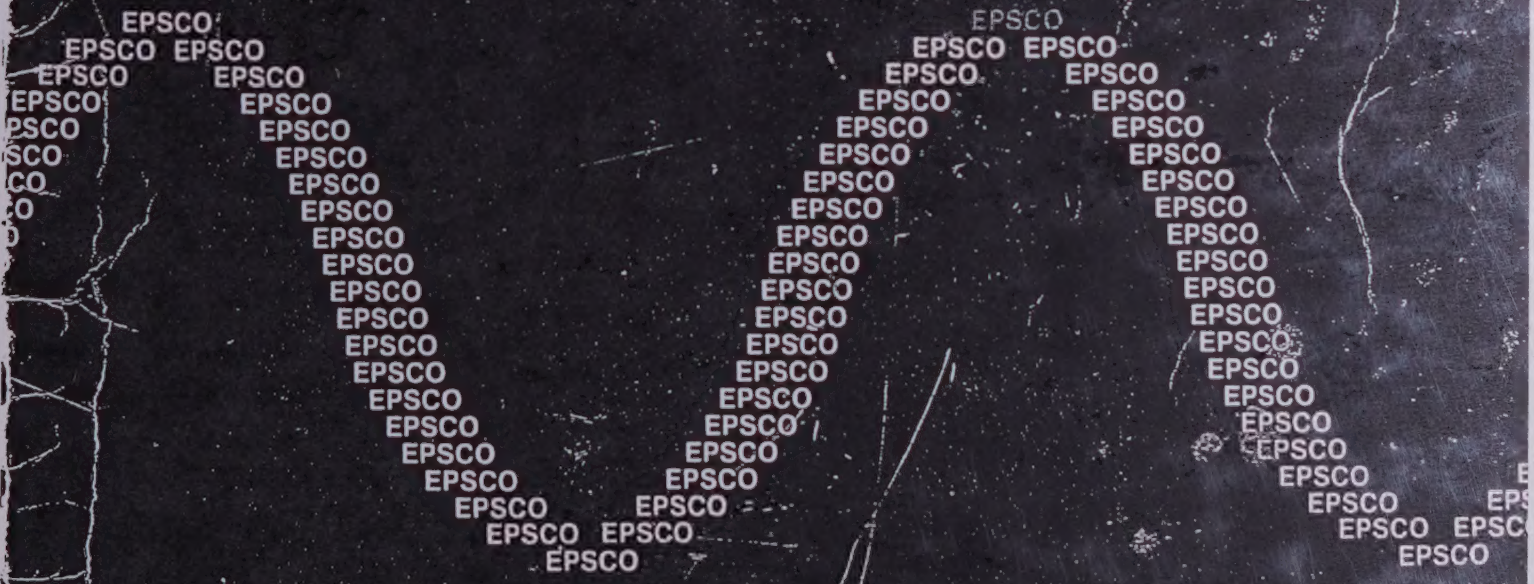
EPSCO Microwave

PRELIMINARY
OPERATION AND MAINTENANCE INSTRUCTIONS
CW Signal Source
Model EP250C



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OPERATION AND MAINTENANCE INSTRUCTIONS

CW Signal Source

Model EP250C

EPSCO Microwave

DIVISION OF EPSCO, INC. / 411 PROVIDENCE HIGHWAY, WESTWOOD, MA 02090 617-329-1500

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Section I

GENERAL DESCRIPTION

1.0 INTRODUCTION

1.1 PURPOSE OF MANUAL

This handbook provides operating and maintenance instructions for the Model EP250C High Power CW Signal Source. It also contains replacement parts lists, schematic diagrams, and mechanical drawings.

Information for the individual plug-in oscillators is supplied in appendices to this manual, where applicable.

1.2 PURPOSE OF EQUIPMENT

The Model EP250C, manufactured by EPSCO Microwave, a division of EPSCO, Inc., Westwood, Ma., is a portable, self-contained RF signal source. It provides, in combination with plug-in cavity oscillators, high power CW signals continuously variable (over the specified range) in amplitude and frequency. This equipment is designed for use in wattmeter calibration, component testing, EMI testing, and medical research.

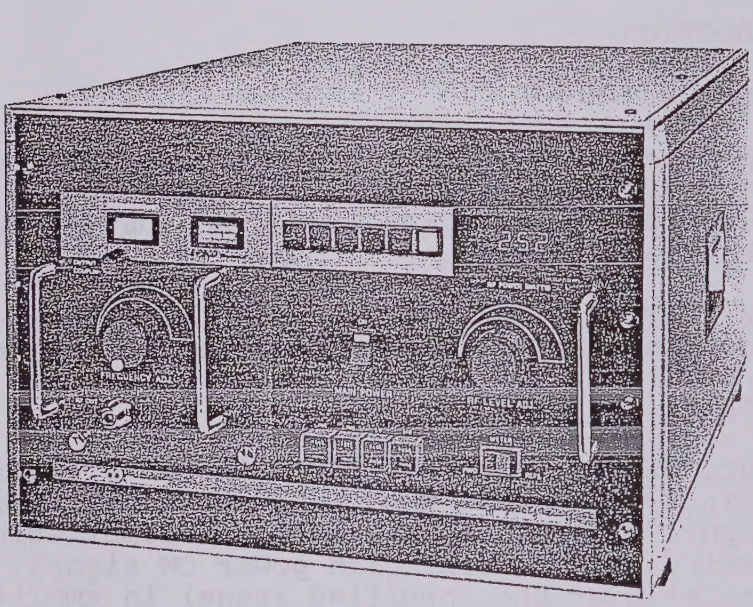
1.3 ELECTRICAL DESCRIPTION

The EP250C consists of the following major assemblies shown in the simplified block diagram, Figure 1-1.

1.3.1 Power Supply

The power supply provides three regulated low voltages required by the instrument. It also provides a non-regulated +8 VDC voltage to the digital card cage where, through a separate regulator, it provides power for logic circuits. Overvoltage protection is provided on all regulated supplies.

The high voltage section of the power supply provides the variable, regulated DC required to power the RF oscillator. The output is adjustable from 0 to -2000 VDC and is connected to the filament transformer secondary via a high voltage cable, and then to the oscillator tube.



FRONTISPIECE - Model EP250C CW Signal Source

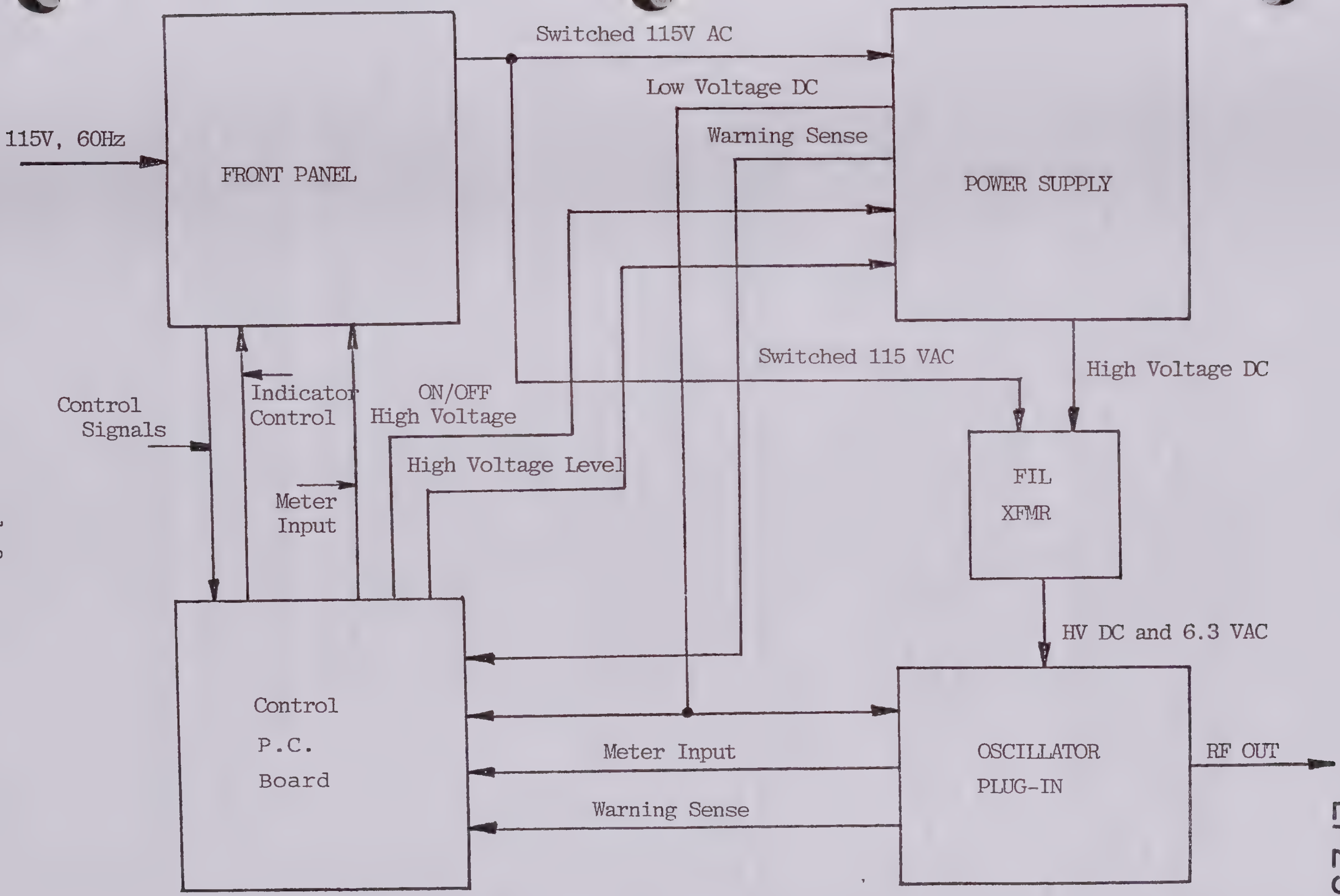

115V, 60Hz
FRONT PANEL
Switched 115V AC
Low Voltage DC
Warning Sense
POWER SUPPLY
Switched 115 VAC
High Voltage DC
FIL
XFMR
HV DC and 6.3 VAC
OSCILLATOR
PLUG-IN
RF OUT
Control
Signals
Indicator
Control
ON/OFF
High Voltage
High Voltage Level
Meter
Input
Control
P.C.
Board
Meter Input
Warning Sense

Figure 1-1. Simplified Block Diagram

1.3.2 Control and Monitor Circuits

Front panel switches and controls provide control of the instrument and the plug-in oscillator output levels via the control and monitor circuits. The forward and reflected power of the RF oscillator is monitored and displayed on a digital meter on the front panel. A switch allows selection of the displayed parameter.

Automatic overload, VSWR, and over-temperature protection circuits, time delay, and sequencing circuits are included in the control and monitor function. High voltage is inhibited by an interlock switch under the cover or by the absence of a plug-in oscillator. High voltage operation is permitted without a plug-in oscillator only when in the SERVICE mode, controlled by a switch on the system control board.

1.3.3 RF Oscillator

The high power RF oscillators which are part of the optional plug-in assemblies are the heart of the EP250C CW signal Source. Each cavity oscillator consists of a planar triode tube mounted in a precision-machined coaxial cavity. Each cavity is silver-plated, then rhodium-finished to prevent corrosion. The frequency is adjusted by a single knob which changes the operating wavelength of the resonant cavity. A dual directional in-line RF power sensor is used with every oscillator plug-in. A detected sample of forward and reflected power is used in the power monitor and VSWR protection circuits. Each oscillator is described in a separate appendix to this manual.

1.4 PHYSICAL DESCRIPTION

The EP250C is a single unit, enclosed power source 19 inches wide, 12-1/4 inches high, and 25 inches deep(exclusive of front panel controls). The basic instrument is completely enclosed for EMI and RFI purposes and is equipped with mounting slides.

The bench-top unit is enclosed in a double-walled outer case with the slides attached to the inner wall of the case for easy access to the unit. In rack-mounted installations, the slides can be attached directly to the rack.

The various plug-in RF generators can be removed and/or installed from the front with the instrument in its operating position.

The major sub-assemblies (power supply, digital card cage, etc.,) are all separately removable. All interconnections are made via plug-in connectors and/or individual Fast-on connections.

Sub-assemblies within the power supply are also modular and for the most part can be replaced without use of a soldering iron.

1.5 EQUIPMENT SPECIFICATIONS

A complete list of the specifications of the EP250C main frame are given in Table 1-1. Specifications related to the individual plug-in oscillators are given in the appendix for the particular plug-in.

1.6 EQUIPMENT SUPPLIED

The CW Signal Source, Model EP250C, is supplied as a complete instrument minus the plug-in oscillator. The following accessories are supplied with the basic instrument:

- 6-foot power cord
- Mounting slides (installed on case)
- Digital card extender board (in card cage)
- Card extractor (mounted on cover)
- Spare 15A fuse (mounted in power supply)

1.7 OPTIONAL EQUIPMENT

A complete complement of standard plug-in oscillator heads are available for use with the Model EP250C Power Source. These plug-in heads cover the frequency range of 10-2000 MHz with power levels up to 350 watts. The standard plug-in oscillators are listed in Table 1.2.

Table 1.3 lists other optional accessories for use with the EP250C.

1.8 EQUIPMENT REQUIRED BUT NOT SUPPLIED

Due to the many possible installation variations, an RF output cable is not supplied with the instrument.

The cable, * to be supplied by the customer, should have the following characteristics:

TABLE 1-1. SPECIFICATIONS

FREQUENCY		
Range	50 to 2000 MHz	
Stability	0.004%/hr. under constant conditions	
Reset Accuracy	0.5%	
LOAD REQUIREMENTS		
Impedance	50 Ohms	
VSWR	1.7 to 1 max. at full-rated power	
POWER		
Input (50-60 Hz)	115V ± 10% at 15 amperes max.	
Output	to 250W (See Table 1-2)	
Stability	± 0.1 dB/hr. under constant conditions	
Range	10 dB minimum	
RF POWER METER		
Resolution	1W	
Accuracy	± 1 dB (20W to full rated power)	
ENVIRONMENT		
Temperature	-5 deg C to 35 deg C (23 deg F to 95 deg F)	operating
	-40 deg C to 70 deg C (-40 deg F to 158 deg F)	non-operating
Dimensions	13 inches high, 20 inches wide, 26 inches deep (benchtop)	
	12-1/4 inches high, 19 inches wide, 25 inches deep (rack-mounted)	
Weight		
Main Frame	100 pounds (benchtop)	
	75 pounds (rack-mounted)	
Plug-In Head	20 pounds	

Characteristic impedence	50 ohms
Connector (instrument end)	Type N (male)
Shield coverage	> 80%

*Type RG 214 or equivalent is recommended

Table 1-2 STANDARD PLUG-IN OSCILLATORS

Frequency (MHz)	Model	Power Out* (Watts)
10-50	M8020H**	250
50-200	M8030H**	250
200-700	M8045H	225
700-1200	M8060H	200
1000-2000	M8070H**	80
2450	M8080H	250

*Power listed is minimum available throughout frequency band covered. Average power available is usually higher.

**Under development. Contact factory for availability.

Table 1-3 OPTIONAL ACCESSORIES

Accessory	P/N	Function
1. Remote Control Interface	**	Permits operation of all instrument functions except Main Power ON/OFF and FREQUENCY ADJ at a distance of up to 50 feet.
2. Remote Control Unit	**	Used with Remote Control Interface option to provide operating controls and displays for operation of instrument.
3. GPIB Interface	**	Permits operation of all instrument functions except Main Power ON/OFF from a GPIB (IEEE-488-1979) standard bus.

Table 1-3 OPTIONAL ACCESSORIES (Cont)

4. External Leveling Kit		Permits RF Output Power Level to be held constant with a varying load. ~~May also be used to provide a low frequency (up to 400 Hz) AM capability for the instrument~~.
5. Spare Parts Kit		Contains replacement fuses and components most subject to accidental overstress.

** Under development - Consult factory for availability

Section II

INSTALLATION

WARNING

HIGH VOLTAGE IS USED IN THE OPERATION OF THIS EQUIPMENT. CARE MUST BE TAKEN TO AVOID CONTACT WITH HIGH VOLTAGE CONNECTIONS WHEN INSTALLING OR OPERATING THIS EQUIPMENT.

BEFORE WORKING INSIDE THE EQUIPMENT, TURN POWER OFF AND GROUND POINTS OF HIGH POTENTIAL BEFORE TOUCHING THEM.

2.1 INITIAL INSPECTION

Upon receipt of the equipment, verify that it is intact and complete as ordered. If damage is discovered, immediately file a claim with the freight carrier and refer to the warranty page at the back of this handbook.

2.2 INSTALLATION - BENCH TOP

Select a location for the instrument that will provide adequate support of the weight (approx. 130 pounds) and enough free air space on all sides to prevent overheating. Assure that there is ample free area in front of the unit for easy access to the operating controls. If the installation requires that the RF output cable be run at right angles to the front panel, a swept right-angle connector should be installed between the RF output connector and the RF cable, rather than making a sharp bend in the output cable.

CAUTION

Placing any objects (books, papers, etc.,) over the exhaust holes in the top of the case will cause an overtemperature condition to occur.

2.3 INSTALLATION - RACK MOUNT

The equipment is suitable for rack-mounting in a standard 19-inch rack using the slides that are attached to the unit.

If rack-mounting is desired for a unit that is supplied with the optional enclosure, perform the following steps:

(a) Remove the four screws on each side of the front panel.

(b) Withdraw the instrument from its enclosure on its slides.

(c) Depress the slide catches and separate the slide sections by pulling the instrument further forward.

(d) Remove the outer slide sections from the enclosure and install them in the rack.

(e) Install the instrument by engaging the slide sections, depressing the slide catches, and pushing the unit into the rack until the front panel can be screwed to the rack uprights using the screws removed in step (a).

2.4 VENTILATION REQUIREMENTS

The hot exhaust ports are located in the left front of the top cover of the unit. Cool air intakes are located on the right front side, the right front bottom, and on the rear panel of the instrument enclosure. There is no intake port at the rear of the instrument proper. Provide adequate clearance (at least 2 inches) near the air intakes and exhaust for free air movement.

In a rack installation, make sure that the air temperature at the intakes does not exceed 40°C (100°F). In some installations, it may be necessary to install ducts or baffles to prevent exhaust air from the EP250C Power Source from reentering its own intakes.

2.5 ELECTRICAL POWER REQUIREMENTS

Be sure that the MAIN POWER switch on the front panel is set to OFF and connect the power cable (supplied) between the twist-lock receptacle on the rear of the unit and the external power supply.

The power supply must be capable of supplying 115V, 60Hz at 15 amperes.

2.6 PRE-INSTALLATION TESTS

The unit requires no pre-installation tests or adjustments prior to use.

Section III

OPERATION

3.1 OPERATING CONTROLS

Before operating the equipment, operating personnel must become familiar with the location and functions of the various controls and indicators. Operating controls, indicators, and switches are shown and the function of each briefly described on Figure 3-1.

3.2 STARTING THE EQUIPMENT

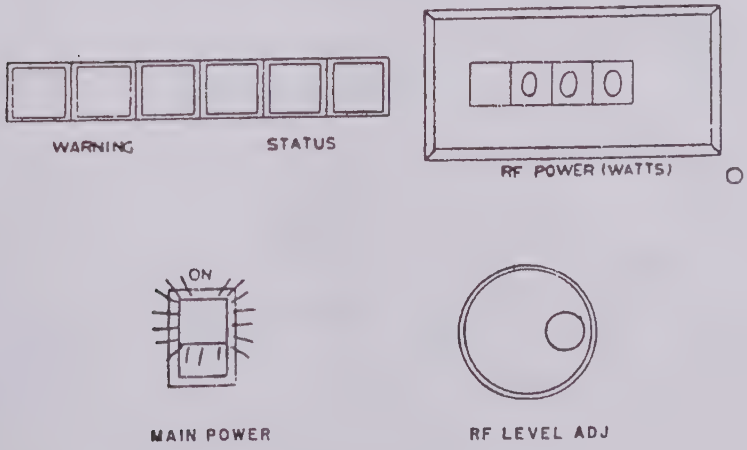
To start the equipment, perform the following steps:

(a) On the Front Panel, set the RF LEVEL ADJ control fully ccw.

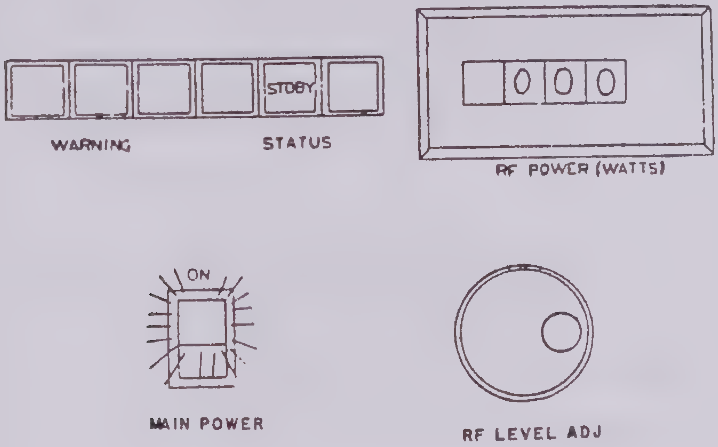
(b) Install the plug-in oscillator unit into the instrument by sliding it into the panel opening and tightening the two knurled locking screws.

(c) Connect an RF coaxial cable between the RF OUT connector of the plug-in and a suitable 50-ohm load having a VSWR of less than 1.5:1.

(d) Set the MAIN POWER switch on ON. The MAIN POWER indicator will light. Front panel indications will appear as illustrated.



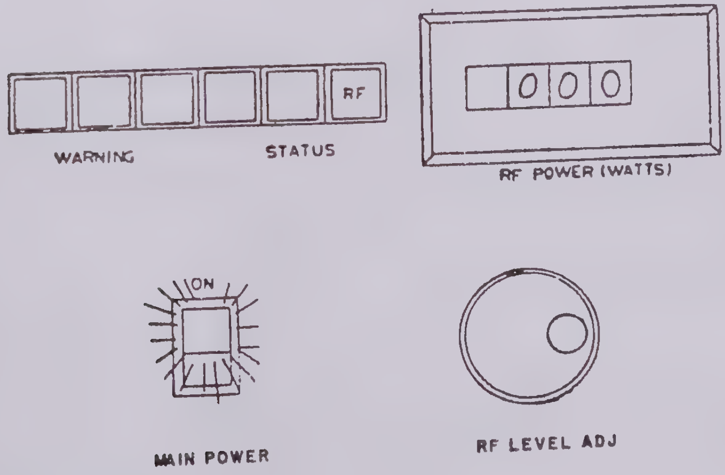
After a five-minute time delay, the STDBY lamp will light, as shown in the following sketch, indicating that the unit is ready to be switched to the RF ON mode.


STDBY
WARNING
STATUS
000
RF POWER (WATTS)
ON
MAIN POWER
RF LEVEL ADJ

(e) Turn the FREQUENCY ADJ knob on the plug-in to the desired frequency of operation as read on the FREQUENCY meter.

(f) Set the OUTPUT COUPLING control approximately midway between its extreme cw and ccw positions.

(g) Depress the RF switch. It will light and the STDBY indicator will go out.


RF
WARNING
STATUS
000
RF POWER (WATTS)
ON
MAIN POWER
RF LEVEL ADJ

(h) Rotate the RF LEVEL ADJ control clockwise until at least 25 watts putput power are indicated on the RF POWER meter. Adjust the OUTPUT COUPLING for maximum power as read on the RF POWER meter.

(i) Rotate the RF LEVEL ADJ clockwise until the desired power level is reached.

Note

To obtain maximum output power, it may be necessary to readjust the OUTPUT COUPLING slightly.

3.3 OPERATING THE EQUIPMENT

3.3.1 FREQUENCY ADJ Control

The FREQUENCY ADJ control can be moved at any time. It is recommended that the power levels be reduced below maximum output before a large frequency change is made. This will prevent changes in coupling requirements from causing an excess output current condition which, in turn, could cause the instrument to enter the Ip shutdown mode.

The OUTPUT COUPLING ADJ should be set for maximum output power when the frequency is at its new position; the RF LEVEL ADJ can then be adjusted to the desired level.

3.3.2 RF LEVEL ADJ Control

Once initial adjustment of the Frequency and Coupling has been made at maximum power, the RF LEVEL ADJ control can be moved to any position at any rate. When the RF LEVEL ADJ is set fully ccw, the high voltage (and RF output) is zero. At the fully cw position, the RF output is at maximum (greater than 225 watts).

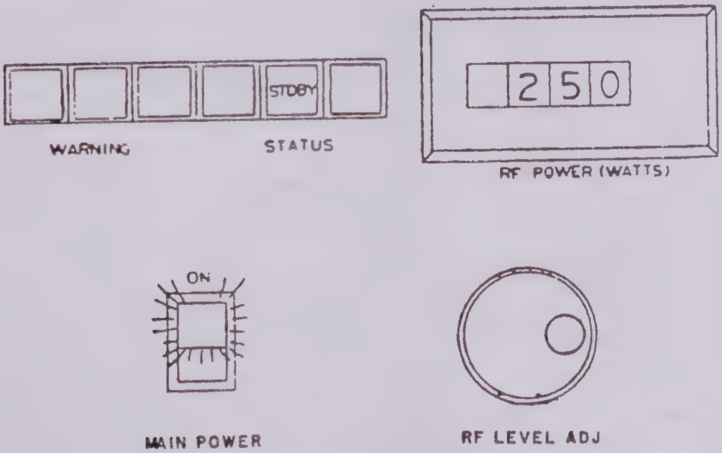
CAUTION

- Maximum output at some frequencies can exceed 500 watts. Operation above this level may damage the power sensor.
- The RF POWER meter is calibrated to read within specifications over the normal operating range of the instrument only. Excessively low readings will be obtained at power levels higher than 300 watts.

Intermediate positions of the RF LEVEL ADJ provide RF output levels from greater than 225 watts to less than 20 watts. Many cavity plug-in units will operate satisfactorily down to levels below 1 watt. Operation is not guaranteed and not recommended at levels below 20 watts without checking the individual cavity for frequency and amplitude stability at extremely low levels.

3.3.3 RF ON/OFF Switch

Depressing the RF switch while in STDBY mode will enable the High Voltage Power Supply. Depressing the RF switch while in the RF ON mode (RF indicator lit) will switch the instrument to STDBY, dropping the RF output power to zero. Depressing the RESET switch while in the RF ON mode will perform the same function. The RF LEVEL ADJ control may be in any position when the instrument is switched to STDBY by either of the above methods.

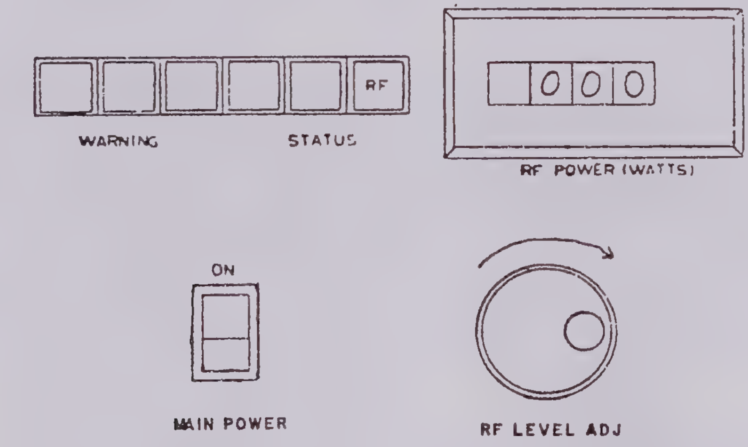


The RF POWER meter assumes a "hold" condition whenever the system goes into STDBY mode for any reason. It will continuously display the last reading taken prior to entering STDBY. This function allows the operator to see the power level that was present when a shutdown occurred. See paragraph 3.3.4, Fault Detection.

Note that selecting the REFL position of the METER switch will not change the reading (other than adding a decimal point) when the unit is in STDBY. It will not be a true reading of reflected power level.

If the RF LEVEL ADJ control is set to provide less than approximately 100 watts (the exact value depends on the plug-in oscillator installed and the frequency selected) when the RF switch is depressed (returning the unit to STDBY), depressing the switch again (RF indicator now on) will cause the RF output to automatically return to its former level. Note that the RF output will slowly increase from zero to the preset level - it will not attain the preset level instantaneously.

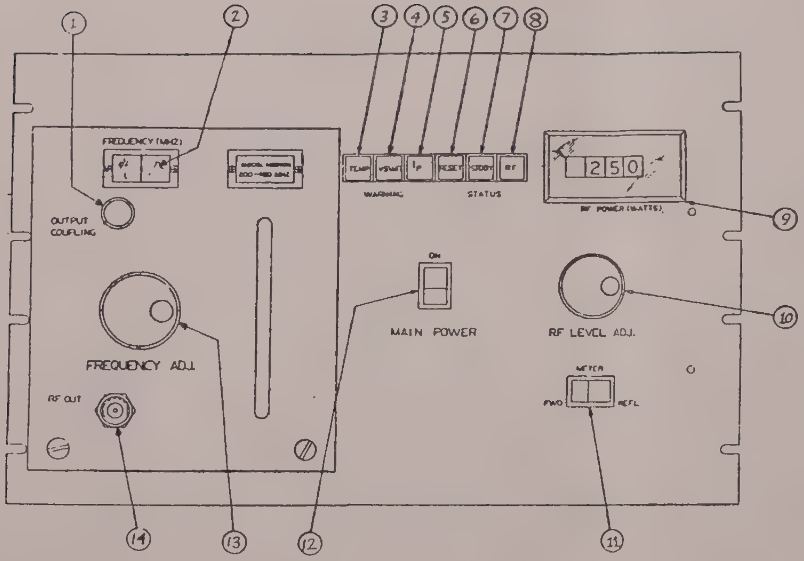
If the RF LEVEL ADJ control is set for an output greater than approximately 100 watts when the unit is switched from STDBY to RF ON, the RF indicator will light, but the HVPS will not be turned on. An "excessive error" detecting circuit will hold the HVPS in the OFF condition. This condition will be indicated by the fact that the RF lamp is on but the MAIN POWER indicator is not lit.



Rotate the RF LEVEL ADJ ccw until the MAIN POWER indicator is lit; then return it to the desired level. Again, the RF output will slowly rise from zero and will stop increasing when it reaches the level determined by the setting of the RF LEVEL ADJ. If the control is set to maximum, it will take approximately 2 seconds for the output to stabilize.

3.3.4 Fault Detection

A fault in any one of three parameters: Ip (cavity anode current), cavity temperature, or VSWR will cause a front panel warning indication and/or shutdown (reverting to STDBY) of the instrument. Two of these, VSWR and Ip, are operator-controllable.



1 OUTPUT COUPLING

Adjusts the RF coupling of the oscillator to maximize its efficiency. The OUTPUT COUPLING control is adjusted to obtain a peak in the forward RF power as indicated on the RF POWER meter.

2 FREQUENCY

Indicates frequency to which RF oscillator is tuned. This indicator is mechanically linked to the oscillator tuning mechanism.

3 TEMP

When flashing, lamp indicates high temperature condition existing in the cavity oscillator. When steadily illuminated, lamp indicates a shutdown due to overtemperature has occurred; the RESET indicator will be flashing.

4 VSWR

When steadily illuminated, indicates a shutdown due to excessively high VSWR has occurred; the RESET indicator will be flashing.

5 Ip

When flashing, indicates that the RF oscillator plate current is approaching the maximum level permitted. When steadily illuminated, indicates a shutdown due to excessively high Ip has occurred; the RESET indicator will be flashing.

6 RESET

This indicator flashes whenever the high voltage has been shut down by the internal protection circuits. During this time, the RF indicator is off and either VSWR, Ip, or TEMP is lit, indicating the nature of the problem. The RF POWER meter will be blanked. After the problem is corrected, depressing the RESET switch will return the system to a STDBY condition. The RF POWER meter will then display the measurement taken at the time of shutdown.

7 STDBY

When lit initially, lamp indicates that the warmup delay is over and RF ON mode may be selected. This lamp extinguishes when the RF mode is selected.

8 RF

Alternate action switch turn high voltage on or off. When lit, the voltage level set by the RF LEVEL ADJ control is applied to the cavity oscillator.

9 RF POWER (Watts)

Meter indicates forward or reflected RF power in watts. The METER switch selects the displayed parameter.

10 RF LEVEL ADJ

Adjusts voltage level applied to the RF oscillator which controls the RF level.

11 METER

Switch selects either forward (FWD) or reflected (REFL) power to be displayed on the RF POWER meter.

12 MAIN POWER

Switch applies AC power to all circuits except high voltage.

13 FREQUENCY ADJ

Control adjusts the operating frequency of the RF oscillator.

14 RF OUT

Type N jack at which the RF output is present.

Figure 3-1. Front Panel Controls and Indicators

HVPS parameters are also monitored, but with the exception of the case described in paragraph 3.3.3, will normally require maintenance action if they shut down the unit.

In the event that a fault which could cause damage to critical circuits occurs, the unit reverts to STDBY with a flashing RESET indicator and a steadily lit warning indicator. The following procedure will return the unit to normal:

Note

> The RF POWER meter will be blanked to prevent false readings in RESET mode.

(a) Depress the RESET switch. Unless the fault condition still exists, the RESET and WARNING lamps will extinguish and the RF POWER Meter will display the value that it was reading at the time the fault occurred.

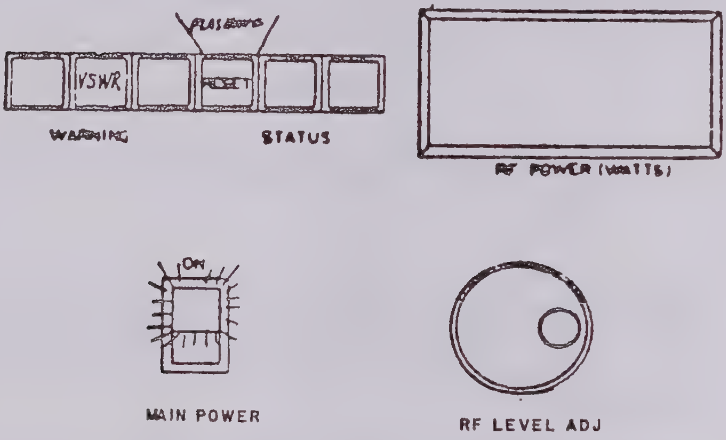
(b) Depress the RF switch and, if necessary, reduce the setting of the RF LEVEL ADJ control below the "excessive error" threshhold.

(c) The instrument should now be in RF ON condition, and the RF LEVEL control can be advanced.

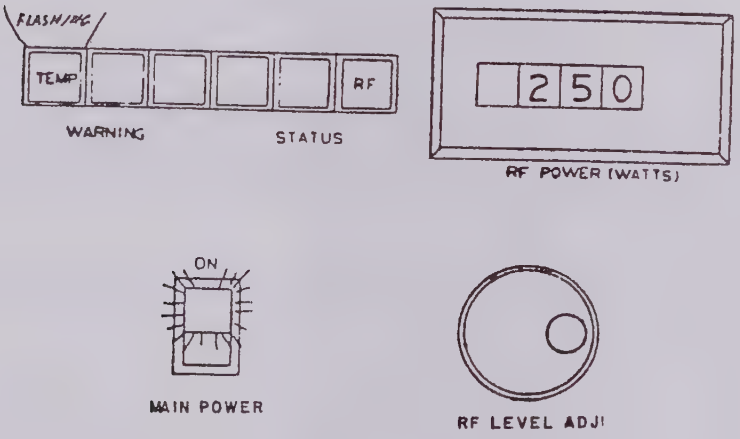
A fault detected by the HVPS internal monitor circuits will not cause the RF lamp to go out, but will indicate the fault condition by extinguishing the MAIN POWER lamp. The HVPS will be shut off, and in all other respects, the instrument will be in STDBY mode.

A description of the individual fault conditions and actions that can be taken follows.

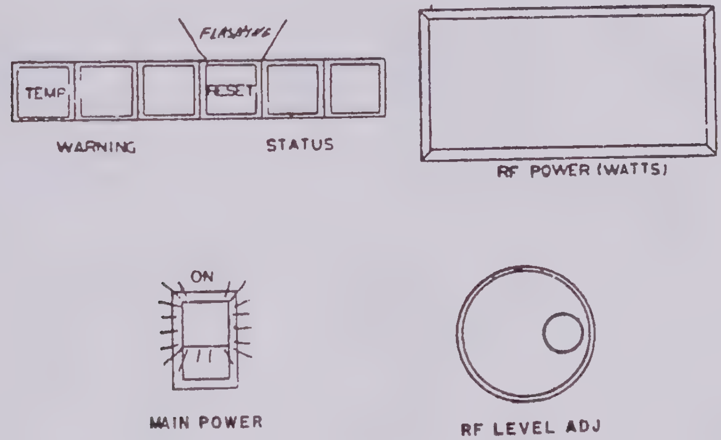
(a) VSWR shutdown - Since an excessive VSWR is usually sudden and caused by a broken cable or other malfunction, no early warning is provided. In the event that the shutdown occurs and no problem is immediately visible, it may be possible to proceed at a lower power level.


FLASHING
VSWR
RESET
WARNING
STATUS
RF POWER (WATTS)
ON
MAIN POWER
RF LEVEL ADJ

(b) Cavity Overtemperature - a TEMP warning is given when the body of the cavity reaches a temperature of 79°C (175°F).


FLASHING
TEMP
RF
WARNING
STATUS
250
RF POWER (WATTS)
ON
MAIN POWER
RF LEVEL ADJ

At a temperature of 85°C (185°F), the HVPS is shut down (unit is set to STDBY).



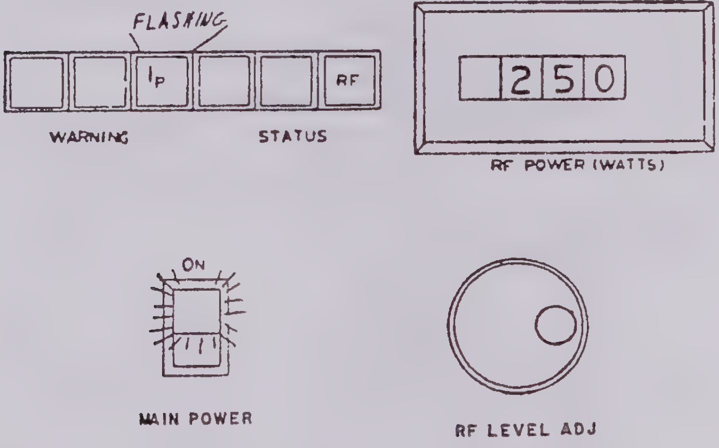
The two temperature fault conditions are indicated by front panel lamp conditions as illustrated.

Since a cavity overtemperature can normally be caused only by an extreme reduction of cooling air, the instrument should be turned off as soon as the TEMP warning light appears and the cause of the problem removed.

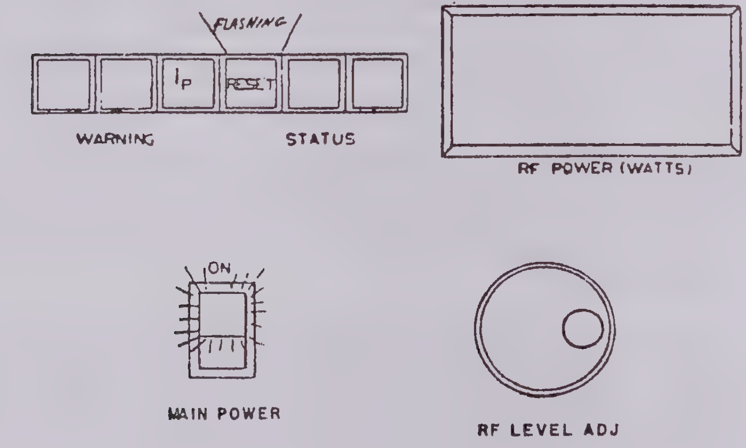
It is possible, however, to operate with the TEMP warning indicator lit (lowering the RF power output level will reduce the temperature), although prolonged operation at this temperature will shorten tube life.

If the cavity temperature reaches the shutdown level (RESET lamp flashing), it can be restored to normal operation (using the procedure described above) only after the cavity has cooled to approximately +40°C.

(c) High Cavity Current - an Ip warning is given when the anode current of the cavity oscillator exceeds approximately 400 ma.


FLASHING
I_P
RF
WARNING
STATUS
250
RF POWER (WATTS)
ON
MAIN POWER
RF LEVEL ADJ

Ip shutdown occurs at an anode current of 500 ma (maximum safe tube current).


FLASHING
I_P
RESET
WARNING
STATUS
RF POWER (WATTS)
ON
MAIN POWER
RF LEVEL ADJ

The instrument may be operated indefinitely with the Ip warning indicator on and may be restored to normal immediately if the Ip shutdown occurs. If the Ip warning/shutdown recurs, then the cavity coupling adjustment should be checked and/or the instrument should be operated at a lower output level.

If an Ip shutdown occurs and the RF output power is below the maximum rating for the particular plug-in installed, refer to Section V of this manual for proper maintenance action.

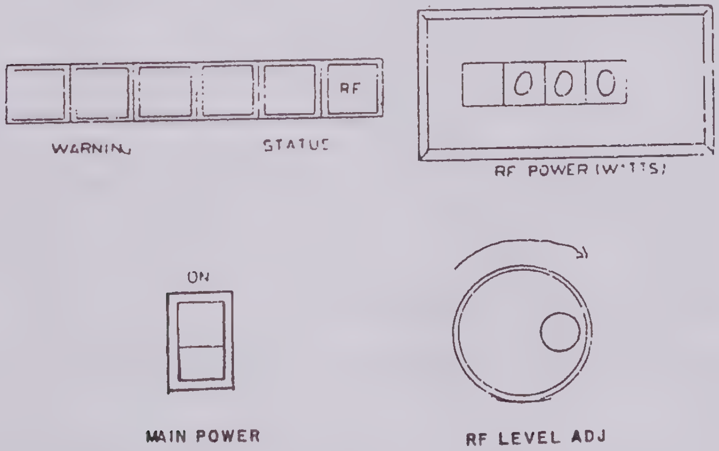
3.3.5 High Voltage Power Supply Fault Detection

Front panel indications of HVPS faults are given only in the RF mode of operation. The MAIN POWER lamp is used as the fault indicator.

One of the parameters monitored by HVPS fault detection circuits is, in some instances, operator-controllable. A HVPS shutdown from "excessive error" may be caused by having the setting of the RF LEVEL ADJ control too high when the RF mode is initiated. (Refer to paragraph 3.3.4).

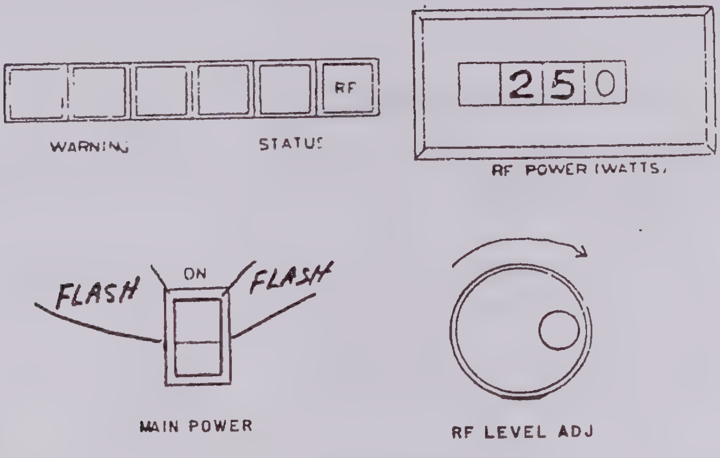
Front panel indications of a HVPS shutdown are:

(a) RF lamp ON, RF POWER meter reads 000, and MAIN POWER lamp out (as illustrated).



If setting the RF LEVEL control fully ccw does not correct the condition, then maintenance action is required. Refer to Section 5 of this manual.

Flashing of the MAIN POWER lamp indicates that current limiters within the HVPS are operating.



The instrument may be operated in this condition indefinitely without damaging the unit This indication is merely to inform the operator that the maximum RF output will be limited to the level indicated on the RF Power Meter unless the frequency and/or coupling is changed.

If the flashing of the MAIN POWER indicator is accompanied by flashing of the Ip warning indicator, adjusting the OUTPUT COUPLING may improve oscillator efficiency and reduce system power consumption. If the Ip warning light is not on, HVPS current limiting is usually due to high AC line voltage.

3.4 STOPPING THE EQUIPMENT

The following shutdown procedure may be used to turn off the instrument.

Functional operation may be stopped by depressing the RF switch. The RF lamp will extinguish and the STDBY indicator will illuminate.

Complete shutdown of the equipment is accomplished by setting the MAIN POWER switch to its OFF position.

Note

It is recommended that when possible, the instrument be operated for several minutes in the STDBY mode prior to setting the MAIN POWER switch to OFF. This prevents the heat buildup that occurs when cooling air is removed from the hot oscillator tube, thus prolonging tube life.

Section IV

THEORY OF OPERATION

4.1 BLOCK DIAGRAM DESCRIPTION

The following description of EP250C operation is intended to provide sufficient information to allow repair of a malfunctioning instrument by replacement of a complete subassembly. Refer to Figure 4-1 for the system block diagram used in this description.

4.1.1 Input Power

Input power is applied to the instrument via a six-foot long, three-wire cable. A line filter directly at the input power connector reduces EMI and RFI signals that could emanate from the instrument via the power line. A 15-amp fuse is connected in series with the high input line as a protective device. A 20-amp fuse in the neutral line assures that the high side of the power line is opened in the event of an overcurrent condition. The fuse in the neutral line is included only for those special order instruments which operate from a 230-V, single-phase line.

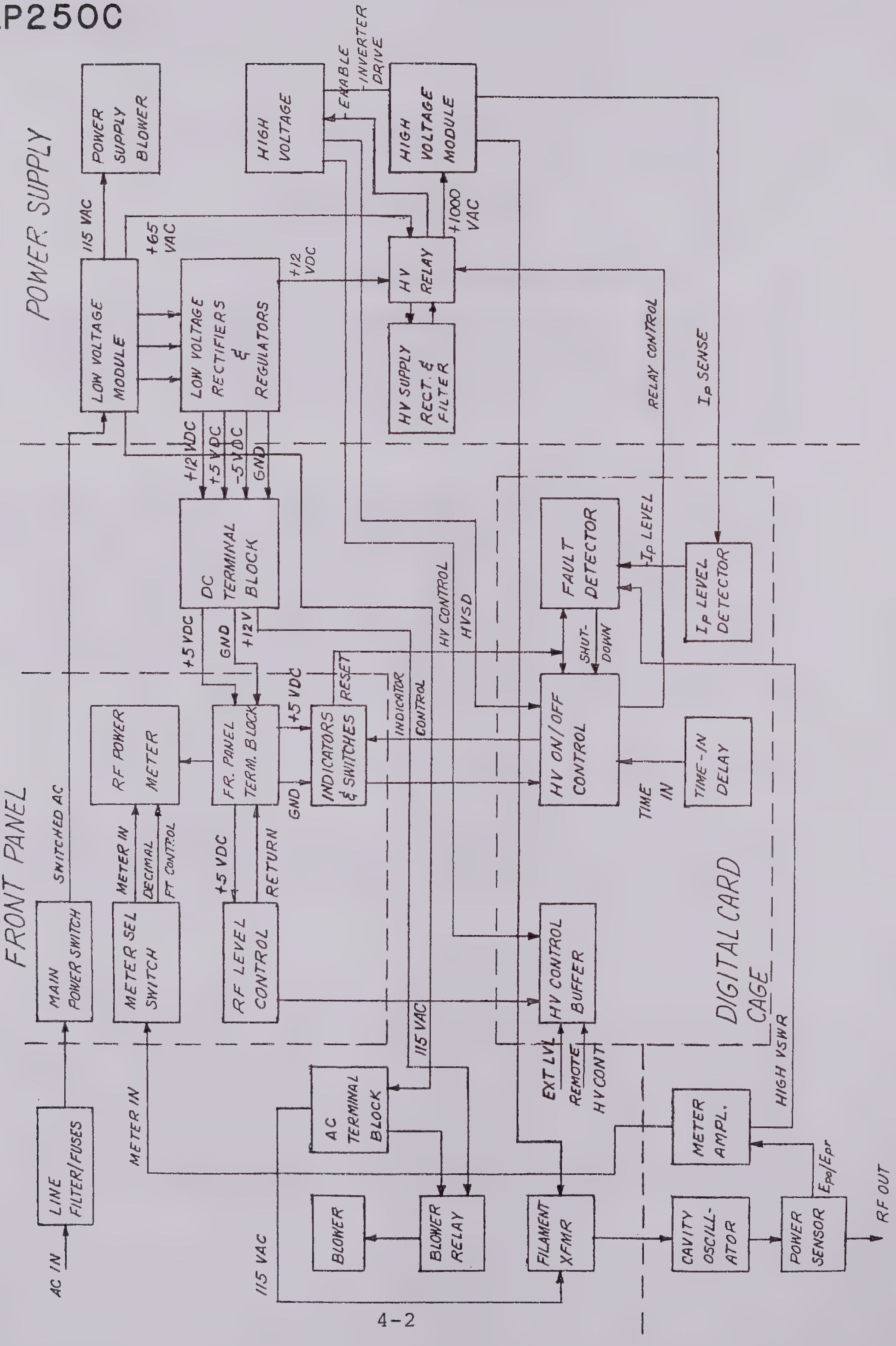
The front panel MAIN POWER control directly switches both sides of the power line.

The switched AC is then routed to the Power Supply where it is connected to the primary of the input power transformer. It is also returned to the AC terminal block for distribution to the blower (via the blower relay) and to the filament transformer.

4.1.2 Low Voltage Supplies

The low voltage supplies use three low-voltage secondary windings of the input transformer to provide rectified and filtered DC voltage of +8 VDC at 5 amps, -8 VDC at 2 amps, and +15 VDC at 2 amps. These three voltages are separately fused and applied to fixed voltage regulators within the power supply to provide regulated, overvoltage-protected outputs of +5 VDC, -5 VDC, and +12 VDC. The +8 VDC supply is also connected to the Digital Card Cage where a separate regulator is used to provide +5 V for the logic circuits.

EP250C


POWER SUPPLY
FRONT PANEL
DIGITAL CARD CAGE
POWER SUPPLY BLOWER
115 VAC
+65 VAC
LOW VOLTAGE MODULE
LOW VOLTAGE RECTIFIERS & REGULATORS
+12 VDC
HIGH VOLTAGE
ENABLE
INVERTER DRIVE
HIGH VOLTAGE MODULE
+1000 VAC
HV RELAY
HV SUPPLY RECT. & FILTER
RELAY CONTROL
I_p SENSE
+12 VDC
+5 VDC
-5 VDC
GND
DC TERMINAL BLOCK
+5 VDC
GND
+12V
HV CONTROL
HVSD
FAULT DETECTOR
I_p LEVEL
I_p LEVEL DETECTOR
SHUT-DOWN
HV ON/OFF CONTROL
TIME-IN DELAY
TIME IN
RESET
+5 VDC
INDICATOR CONTROL
INDICATORS & SWITCHES
GND
FR. PANEL TERM. BLOCK
RF POWER METER
SWITCHED AC
METER IN
DECIMAL
PT CONTROL
+5 VDC
RETURN
MAIN POWER SWITCH
METER SEL SWITCH
RF LEVEL CONTROL
HV CONTROL BUFFER
115 VAC
EXT LVL
REMOTE
HV CONT
HIGH VSWR
LINE FILTER/FUSES
AC IN
METER IN
AC TERMINAL BLOCK
METER AMPL.
E_{po}/E_{pr}
115 VAC
BLOWER
BLOWER RELAY
FILAMENT XFMR
CAVITY OSCILL-ATOR
POWER SENSOR
RF OUT

The regulated +5 V from the power supply is used as the +5 V source for all circuitry not located in the Digital Card Cage. The +12 V and -5 V supplies are used to power the high voltage regulator control circuit, and for power throughout the instrument where these voltages are needed.

4.1.3 High-Voltage Control

This circuitry is mounted on a plug-in P.C. board in the power supply. High voltage is generated by a Pulse Width Modulated inverter which operates from a 100-VDC unregulated supply. The inverter operates at a fixed 20 KHz PRF generated in a switching regulator IC. A 40 KHz oscillator within the IC provides push-pull drive signals to the inverter at the 20 KHz rate. The duty cycle of the drive signals is proportional to the difference between a control signal of +2.5 V to +5 V from the RF LEVEL ADJ control (via buffer amplifiers on the control P.C. board) and a feedback signal of 0 to -5 V tapped from the high-voltage output. Since the pulse width determines the output voltage level, the feedback loop provides the regulation necessary to produce an output voltage level proportional to the setting of the RF LEVEL ADJ control.

Power supply monitor circuits prevent drive signals from reaching the inverter if unsafe conditions are detected. They also provide an indication of the condition of the control card circuits.

4.1.4 High-Voltage Circuits

These circuits consist of an input rectifier/filter, an inverter, and a high-voltage rectifier/filter. A 65 V RMS winding of the input transformer is connected to the input rectifier via the HV relay. The DC output of +100 V (unloaded) is filtered and connected through a 15-amp fuse to the center tap of the high voltage transformer primary. High-power switching transistors which are driven by outputs of the HV control circuit alternately connect the two halves of the HV transformer primary to ground at a 20 KHz rate.

At a greater than 45 percent duty cycle (maximum output), the output of the high voltage transformer is a 20 KHz square wave with a peak-to-peak amplitude of greater than 2 KV. At lower duty cycles, the transformer output is a series of pulses at the same rate. The AC output of the transformer is rectified, filtered, and connected to the secondary of the filament transformer where it combines with the filament voltage to provide the input to the cavity oscillator in the plug-in. A small series resistor in the high-voltage return line provides a voltage proportional to output current for overload detection.

4.1.5 Control Circuit

The control circuit for the high voltage power supply consists of an analog voltage for voltage level control and a relay excitation path for on/off control. Both these signals originate on the control card in the Digital Card Cage.

Circuits on the control card provide the necessary logic to allow the high voltage to be turned on only when all conditions for safe operation are met.

An integrated circuit timer generates a five-minute delay when AC is first applied to the unit. At the end of the delay period, a reset pulse is applied to all registers to assure that high voltage will not be applied immediately, and the STDBY lamp on the front panel is lit to indicate that the system is ready to operate. The control circuits also turn on the cavity cooling blower and place RF POWER meter in a "hold" condition at this time.

Depressing the RF switch applies 65 VAC to the HV supply by energizing the HV relay only if the following conditions are met:

(a) the interlock circuit is closed (indicated by LED on control card being lit), and

(b) all monitored parameters are within safe limits.

4.1.6 Monitor Circuits

The monitor circuits are located in the power supply and in the plug-in to send data to the control board warning and shutdown logic. If any of the monitored parameters exceed the warning level, the appropriate indicator is enabled and a 1 Hz square wave causes the lamp to flash.

If the monitored level increases to the shutdown level, the warning indicator is latched and the RESET lamp enabled. A 2 Hz signal causes the RESET indicator to flash. At the same time, a shutdown detector output resets the RF ON register to the STDBY position. A third output of the fault detector blanks the meter.

Depressing the RESET switch clears the warning latch and resets the shutdown detector. In most cases (overtemperature excluded), the sense input that caused fault detection circuits to operate will be cleared by the shutdown and the instrument ready for operation. In the case of an overtemperature shutdown, hysterisis in the sensor thermostat will cause the fault condition to remain until the cavity cools to approximately 40°C (105°F).

When the unit is in the RF ON mode, a High Voltage Shut Down (HVSD) signal from the power supply will be passed on to the MAIN POWER indicator lamp drive, causing the lamp to go out. When internal power-supply current limiting takes place, a 20KHz train of narrow pulses appears on the HVSD signal line. These pulses trigger a one-shot multivibrator on the control card which holds the MAIN POWER indicator off for about 1/2 second each time it is triggered - thus the indicator flashes at a visible rate.

4.1.7 Analog Control Circuit

The analog control circuit on the control card performs two separate functions:

(a) The high voltage control buffer - acts as a gain of 1 buffer amplifier transferring the voltage level input from the RF-level control through an analog switch to the high-voltage control input to the power supply.

This circuit's main function is used in remotely controlled instruments. In this application, an analog switch allows selection of front panel or remote inputs as the controlling signal for the power supply.

A second input to the buffer is used only in those units equipped with an optional external leveling input. In these units, the controlling voltage to the HVPS is the sum of the voltage from the RF LEVEL control and the voltage from the external leveling circuit.

(b) The Ip sense detector is a dual voltage comparator. The reference levels are adjusted so that input voltage levels proportional to approximately 450 and 500 ma will cause outputs from the Ip warning detector and the Ip shutdown detectors respectively.

The Ip sense voltage input from the power supply is adjustable to compensate for unit-to-unit variations in the current-to-voltage conversion resistor in the power supply.

4.1.8 Meter Amplifier P.C. Assembly

The Meter Amplifier P.C. Assembly is located on a P.C. board mounted in the plug-in head. Although this assembly is not part of the EP250C main frame, circuit descriptions in this section generally cover the circuit for any plug-in. Refer to the Appendix for a description of the differences in plug-ins.

4.1.8.1 Meter Amplifier Circuits - The Meter Amplifier circuits amplify the DC voltage output of the Forward and Reflected Power sensors by a fixed amount. The output voltage to the RF POWER meter is equal to the RF power in watts. Separate amplifiers are used for the two signals due to their different gain requirements.

4.1.8.2 High VSWR Detection - High VSWR detection is accomplished by comparing the outputs of the Forward and Reflected Power amplifiers. A fixed division ratio is included in the Reflected Power circuit so that when a Reflected Power level of 12.4 watts and a Forward Power level of 250 watts are applied to the voltage comparators, the VSWR comparator will operate. These levels represent a VSWR of 1.5:1.

A Reflected Power level greater than 16.7 watts (with 250 watts of Forward Power) will cause the VSWR shut-down comparator to operate.

4.2 DETAILED THEORY OF OPERATION

The following circuit descriptions are designed to provide sufficient information for troubleshooting and repair of the instrument to the component level.

The schematics and interconnection diagram in Section VI should be used in conjunction with the following text to aid in understanding circuit operation.

ADD TO PAGE 4- 6

4.1.9 High Voltage Switch Assembly

This assembly contains the series resistors used for cavity isolation. Two different values are required to match the various cavity characteristics. A high-voltage relay mounted on the board selects the low resistance value when it is energized by shorting out the high resistance component. Circuitry on the board reads the "Plug-In Identity" signal lines from the plug-in. The binary coded information on the three lines is decoded to determine whether a high or low resistance is required. The output of the decoder energizes the relay if a low resistance is needed and leaves it de-energized if a high resistance is required.

In order to reduce descriptive complexity, the following conversion is used to identify the sections of a multiple-function, integrated circuit package.

The section using the lowest numbered set of pins is the "A" section. The next higher set of pins is the "B" section, etc. Thus if U1 is a 7400 quad NAND gate, then the section which uses pins 8, 9, and 10 would be labeled U1C. Note that the letter suffixes do not appear on the schematic diagram.

4.2.1 Digital Card Cage

The digital card cage provides logic power, +5 VDC, for circuitry mounted on the plug-in P.C. boards. It also provides interconnection wiring between the boards and the I/O connector.

Two active components are mounted to the card cage proper. VR1 and Z1 are used to convert the +8 VDC from the power supply to a +5 VDC level (VR1), and to protect card components in the event of a regulator failure (Z1).

A monolithic three-terminal regulator capable of providing up to 1.5A at +5V is installed as VR1 on all but those units equipped with the GPIB interface option. In these units a regulator which can provide 5 amperes is used to handle the extra load.

The overvoltage protection integrated circuit (IC) Z1, which shorts the +5 volt line to ground in the event that a voltage greater than approximately +5.7 volts is detected, will operate with any option installed.

4.2.2 System Control Board

This circuit board contains all of the circuitry required to provide control and drive signals to the front panel or remote unit and to the power supply in response to front panel or remote unit signals.

Because of the close functional relationship of the components, a description of the front panel circuits is included in this section.

4.2.2.1 System Start-Up Circuits - consist of integrated circuit timer U7B and a Power-On Reset Pulse Generator IC, U12A. When +5V is first applife to the card, the trigger input to the timer IC, U7B, is held low by C31 for about 10 msec after the voltage has stabilized.

C31 must charge to at least 1.5V before timing action starts. The delayed rise at U7-8 acts as a trigger for the timer. At U8-1, the delayed rise acts as a reset signal. This assures that the time-in flip-flop, U8A, is reset and will not enable any control circuits until after the time delay.

The delay time period is determined by the time constant of C37 and R33. The values selected provide a nominal delay time of 5 minutes. When no plug-in is installed, the long delay is not required, and the following action takes place. A missing plug-in puts a logic high level at the three PLUG-IN IDENT inputs of U16A and allows the voltage at S1-5 to go high (about +4V). The NORM/SERVICE switch S1 at the top of the control card is placed in the SERVICE position, placing R20 in parallel with R33. The time delay is reduced to about 15 seconds. A second set of contacts (pins 7 and 8) on S1 provides a bypass for the cover interlock switch enabling the input at U16-11. The "Interlock" indicator at the top of the card will also illuminate.

If a cavity plug-in is installed and the NORM/SERVICE switch is in the SERVICE position, C37 will be held at 2V preventing U7B from completing its cycle and thus preventing the instrument from turning on.

At the end of the delay period, the logic level transition at U7-9 from a high (1) to a low (0) in inverted and used to clock the time-in flip-flop, U8A, to the set condition. The high to low transition at U8-6 triggers the Power On Reset one-shot, U12A. The high level signal at U8-5 (TIME IN) enables U10A and U10B, allowing the STDBY lamp on the front panel to illuminate. Base current to Q1 is increased until the transistor saturates, providing a current path to ground for the blower relay (on the main chassis) coil. The relay energizes and turns on the blower motor.

The 50-msec pulse output of U12A holds the two control flip-flops U6A and U8B in a reset state until transients generated by the blower motor start have subsided.

4.2.2.2 RF ON/STDBY Mode Control - signals are all applied to the RF ON/STDBY flip-flop, U6A. When the instrument is first turned on, this flip-flop is forced into its reset condition (STDBY mode) by the POWER ON reset signal. At the completion of the Power On Reset, a low-level signal appears at U21-6 (both inputs low). This low is sent to U20-11 where, since U20-9 and U20-10 are both low unless the RESET switch is depressed, it causes a high at U20-8. This high enables the shutdown flip-flop, U3B, and the third input to the OR gate U16C. (Unless there is a fault condition, U16-10 will also be high). The resulting high at U16-8 enables U6A by releasing its RESET input, pin 1.

When the front panel LOCAL/REMOTE switch is in the LOCAL position, the active low NAND gate U23B is enabled by a logic 0 at pin 5. In units not equipped with the Remote Control option, this pin is held low by a jumper from the $\overline{\text{LOCAL}}$ line to ground.

A $\overline{\text{RFSW}}$ signal (logic 0) at U23-6 from the front panel RF switch is passed through U23B and appears as a high at its output, pin 4. The low-to-high transition provides a clocking signal at U6-3. The Q output at U6-5 goes to the level that was present at the "D" input (pin 2) at the time the clock occurred. This level will be a high, since with U6A in a reset state, its Q output (pin 6) is high.

When U6A is set by the transition at pin 3, its $\overline{\text{Q}}$ (pin 6) output goes low, placing a low at its own D input (pin 2). A second depression of the RF switch would then clock the flip-flop back into the reset state. Thus the RF switch in conjunction with U6A acts as a push-on/push-off alternate action switch.

This action is made possible without the use of switch debounce circuitry by use of Hall effect switches at the front panel. Hall effect switches produce clean, bounceless outputs with single on/off and off/on transitions.

As can be seen in the schematic diagram, there are some constraints on the alternate state switching of U6A. There are three separate inputs which can produce a reset signal (logic low) at pin 1. This will cause the flip-flop to go into the reset state (regardless of the D input level) and remain there as long as U6-1 stays low. This means that the three inputs at active low OR gate U16C must all be high for the RF ON mode to be entered.

Signal inputs at U16-9 and U16-10 have been previously covered, and the $\overline{\text{SD}}$ signal at pin 10 is discussed in paragraph 4.2.2.3.

4.2.2.3 Fault Monitor Circuits.

Digital alarm signals from the Temperature and VSWR detectors are applied to the transparent latch U24 via pins 38 and 36 of the card connector. The spare input at pin 35 is not used in the manual system and is held at +5V by a 1K ohm resistor in U27.

The digital Ip warning signal at U24-7 is obtained from the Ip level detection circuit (discussed in para. 4.2.2.4) on the control card.

The "no fault" condition of these signals is a logic high. To trace circuit action, assume a low level at U24-2 (indicating a high cavity temperature). Since the latch is enabled by a high level at U24-4 and U24-13, the low is inverted and appears at U24-1 as a high. It is also passed through the latch without inversion to U24-16 and then to U14-2 for use in a GPIB-controlled system. The high at U24-1 is applied to U17-1 as an enabling signal. A second input, at pin 2 of the lamp driver U17, is obtained from a one-second flash generator. The output at U17-3 causes the TEMP indicator on the front panel to light when it is low and extinguish when it is high. R5 is used to cause a low current to flow through the indicator lamp at all times, thus reducing thermal shock and extending long life. The indicator thus flashes at a once-per-second rate.

Low levels at the spare or Ip alarm inputs at U24-6 and U24-7 except VSWR (pin 3) cause functions similar to those described above, but with the flashing indication occurring at the appropriate indicator. A low at the VSWR alarm input U24-3 automatically causes a shutdown to occur through the connection of the logic low at U24-12 to pin 13 of the shutdown gate U25. The output of U24 is used to trigger the shutdown function (described in a following paragraph) rather than input to the card to assure that the latch is properly set up to display the fault.

A low at any input (pins 9, 10, 12, or 13) of U25 initiates system shutdown. Circuit response is as follows: the low at the input of active low OR gate U25 causes a low at U25-8 which is applied to the "set" terminal (pin 10) of flip-flop U8. The low "sets" the output at U8-9 to a high and the level at U8-8 to a low. The low at U8-8 has the following effects:

(1) U24 is disabled by the low at pins 4 and 13 causing its output to remain constant regardless of input changes;

(2) a low is applied to the "reset" terminal (pin 1) of U6 via pins 10 to 8 of U16 causing the system to go to the Standby mode; and

(3) the low at U6-13 forces this flip-flop into the "reset" condition causing a constant high at U6-8 allowing any enabled lamp driver to produce a steady "on" indication.

The high at U8-9 enables the RESET lamp driver U9 so that the one-half second flash signal at U9-6 causes the RESET lamp to flash at the higher rate.

The one-half second flash signal is generated by U7A which is connected as an astable multivibrator. The combination of C33, R34, and R38 set the basic frequency at about 2 Hz. The diode CR4 effectively removes R38 from the charging circuit with the result that the output waveform at U7-5 is close to a square wave. This signal is applied to U9-6 causing the one-half second flash rate. It is also applied as a clock at U6-11 and as a disabling signal at U11-13. At the latter point, it forces the POWER ON indicator to flash at a one-half second rate whenever the one-shot, U12, is being triggered. (At this time, the power supply is in internal current limit mode.)

The connection between U6-8 and U6-12 causes this flip-flop to divide the 2-Hz clock by 2, providing the one-second flash signal at its output, pin 8. U6-8 is held low during the Time-In period by the low level signal at the "set" terminal U6-10.

The SD signal at U8-8 is also applied to the bus driver U13 for status information and to connector pin 29 as an interrupt for the GPIB controller interface.

4.2.2.4 Ip Level Detection Circuit

A dc voltage of 0 to +1.0 volts proportional to High Voltage Power Supply output current (1.0 V = 0.5 Amperes) is applied to the inverting inputs (pins 2 and 6) of both sections of the dual voltage comparator U5. A reference voltage obtained from the voltage divider R4, R25, and R26 is applied to the non-inverting inputs. The Shut-Down differential adjustment R4 sets the differential voltage level between the voltages at U5-5 (warning input) and U5-3 (shutdown input). The input voltage is divided in proportion to the relative values of R24 and the combination of R3 and R23. R3 is adjusted to compensate for unit-to-unit variations in the Ip Sense voltage at connector pin 21.

When the voltage at U5-6 goes more positive (by a few millivolts) than the reference voltage at U5-5, the logic level output at U5-7 drops low. This signal is connected to the Fault Monitor circuit at U24-7. The warning circuit, described in para. 4.2.2.3, causes the Ip Warning indicator to flash.

If the voltage at U5-2 continues to rise until it exceeds the shutdown reference value at U5-3, a low at U5-1 initiates the Ip shutdown sequence.

4.2.2.5 RF Level Control

This circuit provides the necessary amplification and offset that is required to allow the full range of High Voltage Power Supply control by either the front panel RF LEVEL control or by the analog output of one of the two optional remote control interfaces. A second amplifier is included for use when the external leveling option is installed.

A +2.5 to +5.0 VDC level is applied to pin 2 of the analog switch U4 via summing resistor U3 (pins 8 and 9) and connector pin 23. A low level (local) signal at U4-1 and accompanying high at U4-8 select an internal low impedance path from U4-2 to the output at U4-5. It should be noted that the (local) line is connected to ground by a jumper on the control board is systems without remote control capability. The analog voltage at U4-5 is connected to the inverting input of an operational amplifier U2-2. The operational amplifier is referenced to ground via the temperature-compensating resistor R19 at U2-3. The -2.5 to -5.0 volts at U2-1 is fed back through U4 to sum with the input voltage. The 10K-ohm resistor U3 (pins 7 to 10) in the feedback gives the amplifier a gain of -1. The negative output at U2-5 is connected to the inverting input of a second operational amplifier at U2-13 through a summing resistor U3, pins 5 to 12. Feedback from U2-14 via U3 (pins 6 to 11) also gives this operational amplifier a gain of -1. A reference voltage of 0 to +2.5 volts is applied to the non-inverting input at U2-12. The HV CONT output at U2-14 is thus the sum of the voltage output of the RF LEVEL control and the voltage at the arm of balance resistor R1. R1 may be adjusted to compensate for manufacturing tolerances and apply exactly +2.5V to the High Voltage Power Supply when the RF LEVEL is set to its fully ccw position.

This circuit functions in the same manner when remote control of the High Voltage Power Supply is required except that the high level that would be applied at U4-1 and the low at U4-8 would effectively disconnect the front panel control and allow the HV CONT output to follow the level at connector pin 37. In this case, the 10K ohm summing resistor is located on the interface board.

4.2.2.6 Remote Control Circuits

Tristate buffers U13, U14, and U15 are used to provide system status data to the microprocessor in the GPIB-controlled version of the EP250C. The octal decoder U19 is used to decode the levels on the address bus and activate the appropriate output buffer. Since these devices are used only with the GPIB option, the chips are not normally installed on the control card of manually-controlled instruments. A complete description of GPIB interface operation is given in Appendix I of this manual which will be included if/when the GPIB option will be installed.

4.2.3 Power Supply

4.2.3.1 Low Voltage DC Power - Low voltage supplies are provided for outputs of +5, -5, and +12 VDC. Separate secondary windings on Input Transformer T1 provide the source of the individual voltages. The AC outputs of T1 are connected to identical rectifiers on the low voltage chassis via P1/A3J2.

Since the three circuits are very similar, only the +5 volt circuit will be described and differences pointed out.

The output of bridge rectifier CR1 is filtered by C1 and the output connected to the regulating circuits via a 1-ampere fuse, F4. The +8 to +11 VDC at this point is also connected to the digital card cage via F3 and connector J1. The fairly wide variation in DC voltage is due to the high current capability of the circuit, i.e.; in a manual unit, the total load is just over 1 ampere. At a high input line voltage, the rectified voltage will be greater than 10V. On the other hand, a full GPIB remote system requires nearly 5 amperes total, and at low line inputs, the DC voltage will be only slightly over +8 volts. At least 8 volts is required for proper regulator operation.

Note

> With GPIB remote option, a 5-ampere fuse is installed at F3 in place of the 1-ampere value used in the manual instrument.

The filtered +8 volts is applied to the input of the fixed +5 volt regulator VR1. This device is not adjustable and can provide a regulated output in the range of +4.75 to +5.25 volts at up to 1.5 amperes.

A regulator failure which could result in placing the unregulated voltage on the output is prevented from damaging the +5 volt components by the overvoltage protection IC, Z1. This device contains a level detector and an SCR which shorts the +5 V line to ground if an excessively high voltage is detected. The short will then cause fuse F4 to blow, thus removing the voltage and preventing further damage. The regulated +5 volts is fed to J1 and from there to the rest of the instrument (with the exception of the digital card cage).

Operation of the +12 V circuit is identical except that a +12 volt, 1.5-ampere regulator VR2 and +12 V overvoltage protector Z2 are used. In the -5 volt circuit, capacitors A3C6 and A3C7 and diode A3CR4 are added to VR3 to prevent oscillation in the less stable negative regulator. In addition, the different terminal arrangement of VR3 and -5 V overvoltage protector Z3 (case is not ground) requires the use of insulation pads in the installation of these devices.

4.2.3.2 High Voltage Input - The input for powering the high voltage inverter is obtained from a 65 V RMS secondary winding of T1. This voltage is applied to CR1 through varistors R1 and R2. These two voltage-variable resistors present an impedance which varies with voltage.

At turn on, they prevent high initial charging currents (for C1) from exceeding the surge ratings of CR1. After the initial surge, their resistance drops to less than 0.1 ohm. The AC line from T1-15 is switched by one set of contacts of K1, thus no AC voltage is applied to the input circuit unless K1 is energized (RF ON mode).

The output of CR1 is filtered by C1 and applied to a second set of contacts of K1. When the relay is deenergized, C1 is discharged by bleeder resistor R3. When K1 is energized, R3 is disconnected and the +100 VDC output of C1 is connected to the inverter through F1.

Switching the bleeder into the circuit only when the inverter is not energized allows a lower value of resistor to be used, thus reducing the time that a dangerously high voltage is present after the unit is turned off. The voltage at C1 is also available at J1-2 for test purposes.

4.2.3.3 High Voltage Control Circuit - High voltage control circuit components are, for the most part, mounted on the HV Control P.C. board, with only the final switcher-drive stage components mounted on the chassis of the Low Voltage Assembly for heat dissipation purposes. Control of the pulse-width modulated switching supply is centered in the switching regulator IC, U1.

This multifunction device (refer to Figure 4-2) contains a relaxation oscillator which produces the switching frequency. The oscillator's frequency is set by the combination of C24 and R26. R26A acts as a trimmer to ease the task of setting

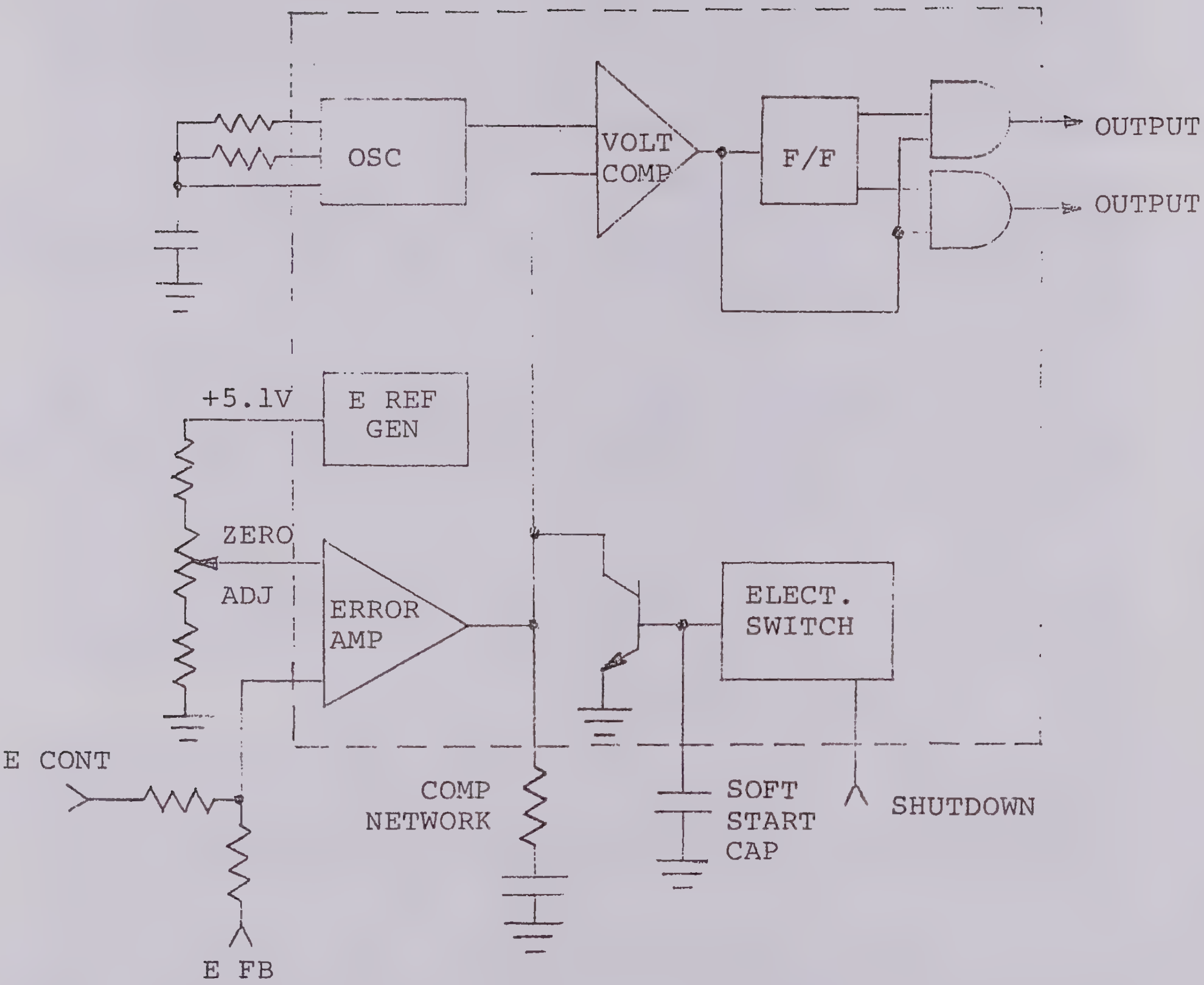

OSC
VOLT COMP
F/F
OUTPUT
OUTPUT
+5.1V
E REF GEN
ZERO ADJ
ERROR AMP
ELECT. SWITCH
E CONT
E FB
COMP NETWORK
SOFT START CAP
SHUTDOWN

Figure 4-2. Switching Regulator IC

the frequency to 40 KHz. The oscillator operates at twice the switching speed in a push-pull supply. During the discharge portion of the oscillator's cycle, C24 is discharged through R27 and R27A. During the discharge period (dead time), neither output transistor can conduct, thus the drive to each switching transistor is limited to approximately 45 percent of the total cycle, preventing the possibility of having both transistors conduct at the same time.

The sawtooth output of the oscillator is applied to one input of a voltage comparator internal to U1. The second input to the comparator is obtained from the output of the error amplifier, also internal to U1.

The error amplifier senses and amplifies the difference between a reference voltage - from a voltage reference source - again inside U1, which is connected to its inverting input terminal via the "zero" control U5. The sum of the voltage on the HV control line (+ 2.5 to + 5.0 VDC) and the feedback voltage from the high voltage output (0 to -5.0 VDC) is connected to the non-inverting input of the error amplifier U1-2. The amplified difference between these two inputs (0 to +12 VDC) is applied to the second input to the voltage comparator.

The zero control is used to balance the error amplifier at the minimum HV control voltage allowing use of the full range of the RF LEVEL control. A compensation network C25 and R34 provides proper phase relationship between output voltage variations and the correction inputs from the feedback circuit.

The regulator causes the output voltage to go to zero, regardless of the error amplifier input levels, whenever the voltage at the shutdown terminal U1-9 goes high (above +2V). The shutdown circuit gets its input from the power supply monitor circuits which are discussed in paragraph 4.2.3.6.

The electronic switch in U1, which is controlled by the shutdown input, causes the DC input to the voltage comparator to drop instantly ($<$ 1 usec) when U1-9 goes high. When U1-9 goes low, a constant current source in the electronic switch causes the voltage comparator input to rise at a rate determined by the soft-start capacitor C23 until the error amplifier output level has been reached. Approximately 2 seconds is required for the voltage to rise to maximum from a soft start.

The output of the voltage comparator goes high when the ramp input (from the oscillator) starts. It goes low when the ramp voltage equals the DC level on the second input (from the error amplifier). The comparator output, then, is a pulse train at a frequency of 40 KHz. The positive pulse widths are proportional to the error amplifier output level and thus follow the setting of the RF LEVEL control; i.e., the higher the HV control voltage, the wider the pulses must be to produce a negative feedback voltage which will balance the error amplifier.

The comparator output is gated alternately to two buffers by the flip-flop circuit. Each of the two outputs of U1 are pulse trains at 20 KHz which differ only in their phase relationship. Each of the two variable pulse-width outputs of U1 are used to provide base drive to one of the two power switching transistors located on the High Voltage module. The two drive circuits are identical and only one is described here.

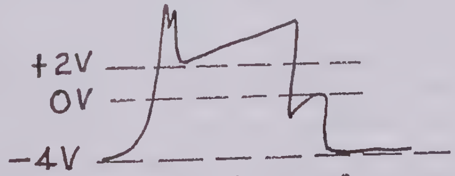
The positive pulse from U1-11 is connected to the base of inverter Q1 through R6 and speed-up capacitor C21. Q1 provides the current capability required to power the drive circuits. The negative-going pulse at its collector is connected through CR2 and the combination of R8 and speed-up capacitor C5 to the card connector pin D, and then to the base of the turn-on drive transistor A3Q1 on the chassis. R5 back-biases CR2 during the off periods, and R10 assures that the drive transistor Q1 turns off quickly when the drive pulse is removed. C27 in parallel with CR2 provides overdrive capability, so that the output of A3Q1 will have a fast (< 100 nsec) rise time. Since turn-on drive transistor A3Q1 is a PNP device, its collector voltage rises to nearly +12 V when it is saturated by the negative signal at its base. The collector of A3Q1 is connected to the base of switch transistor A1A1Q1 through A3R1 and A3F6 via connector A3J3-B. A3R1 limits base drive current to about 700 ma, which is sufficient to hold A1A1Q1 in saturation during the entire on time.

The 8.2-V zener diode A3CR8, which is connected to the output line through diode A3CR7, acts as a safety device in two ways: 1) in normal operation, it limits the voltage that can be applied to the base of A1A1Q1 to approximately +9V, thus preventing possible damage to the switch transistor, and 2) in the event of a malfunction in A1A1Q1 (its normal failure mode is a short from base to collector), A3CR8 prevents the high voltage (in excess of 100 V) from destroying the drive circuit by holding the voltage at the junction of A3R1 and A3CR7 to +9 V, long enough for fuse A3F6 to blow.

During the period that A1A1Q1 is off, its base must be held negative with respect to its emitter to allow it to withstand the high switching currents and to reduce storage time within the transistor. The portion of the drive circuit described in the following paragraph is used to accomplish this task.

The output of Q1 on the P.C. board, a negative-going pulse which performed the turn-on function as described above, is also connected through CR5 to the turn-off drive circuit. Since the output of CR5 swings between +12 V and ground, and the turn-off circuit operates at a -5 V level, the combination of Zener diode CR4 and overdrive capacitor C8 is used at provide the voltage level translation. R11 reverse-biases CR5 during the off period and also provides forward bias for pulldown transistor A3Q2. A3Q2 is thus held in a saturated condition between output pulses. In this condition, its collector is at a level of approximately -4 V which provides the necessary reverse bias for switch transistor A1A1Q1. Although it only operates at a collector-to-emitter voltage of 17 V, A3Q2 must be able to handle the reverse bias current pulses of A1A1Q1 which can be in excess of 7 amperes. It must also have sufficient speed so that it will turn off during the rise time (< 100 usec) of A3Q1 and turn on very quickly to reduce the switching power losses in A1A1Q1. The use of a high-current Darlington switch transistor for A3Q1 and the bias and speed-up components R33 and C6 on the HV control P.C. board accomplish this task.

The base drive signal illustrated below is identical for A1A1Q1 and A1A2Q1 except for the time relationship. Refer to Figure 5-3 for timing and wave form.



Base Drive Pulse

The peak at the beginning of the pulse is caused by the overdrive components which speed up the rise time. The signal is then held at a voltage determined by the base-to-emitter voltage drop plus emitter-resistor drop for the remainder of the pulse. The slow rise is due to the increase in emitter-resistor drop as collector current through the transistor increases. At turn-off, the base is held at the 0 V level during the period that the stored charge is being removed from the transistor, then drops to its normal reversed bias condition.

4.2.3.4 Inverter Circuit - The inverter circuit consists of the two switch transistors A1A1Q1 and A2A2Q1, high voltage transformer A1T1, and various passive components.

When a positive drive pulse is applied to the base of A1A1Q1, its collector drops rapidly to the saturation level (1 to 4 V above the emitter voltage, depending on collector current), allowing current flow through one half of the primary winding of A1T1 to the Vcc source (+ 100V) at its center tap (pin 2). Current through the winding increases in a nearly linear fashion throughout the time that A1A1Q1 is on, due to the inductance of the transformer. A1A1Q1 never stays on long enough for A1T1 to saturate.

At the same time that A1T1-1 is pulled to ground by A1A1Q1, the other end of the primary, A1T1-3, is raised to nearly + 200 V by transformer action. A1A2CR1 is then forward-biased, allowing the + 200 V to charge A1A1C1 and A1A2C1. A1A1R1 and A1A2R1 prevent the voltage across the capacitors from exceeding twice the Vcc potential and the stored charge is available to help power the inverter. The series combination of 180 V Zener diodes A1CR2 and A1CR3 prevent voltage peaks (reflected from the secondary) from damaging the switch transistors.

A current snubber circuit A2A1C1, A2A1CR1, and A2A1R1 is connected from the collector of A1A1Q1 to ground. This circuit reduces transistor power dissipation during the turn-off time. It absorbs a portion of the transformer primary current by the charging of A2A1C1, which also delays the rise in collector voltage. A2A1CR1 allows A2A1C1 to charge at the maximum rate during turn-off switching, and A2A1R1 reduces the discharge rate at turn on. A2A1C1 holds the charge during the entire off time of A1A1Q1. A2A2C1, A2A2CR1, and A2A2R1 perform the same function for A1A2Q1.

4.2.3.5 High Voltage Generation - The high voltage circuit consists of a bridge rectifier, a single-section, choke input filter, a catch diode, and a bleeder resistor.

Although this circuit works in the same way as any low frequency rectifier with a sinusoidal input, the high frequency square-wave input adds complications.

Rectifier diodes with the required voltage and current capability cannot recover (change from the conducting to the non-conducting state) in the time that the input voltage swings from positive to negative. Since the input is a square wave, the transformer secondary is essentially short-circuited during the recovery period (up to 0.5 usec). This, in turn, causes extremely high current pulses (in the order of 300 amperes) in the primary. High voltage pulses are also coupled to the inverter by the winding-to-winding capacitance of the high voltage transformer. The capacitive transfer problem is eliminated by double-shielding within A1T1. The reflected current spikes are held to less than 150 amperes by the catch diode A1CR2 which eliminates energy contribution by the filter choke during the recovery period.

A second problem occurs when the power supply is set for voltages less than maximum (the input is a pulse train rather than a square wave). Under these conditions, the primary of A1T1 is open-circuited (both transistors off) for long periods of time and the combination of inductances (transformer and choke) and capacitances (filter capacitor and rectifier diode capacitance) form a tuned circuit which can ring, lowering the DC output and causing EMI. This problem is reduced by the catch diode A1CR2 which returns the energy stored in the choke to the output during the dead time.

Bleeder resistor A1R1 discharges filter capacitor A1C1 when power is removed, and feedback resistor A1R2 is used to sample the output voltage for input to the regulator circuit.

A1R3, a 2-ohm resistor in the high voltage return line, provides a voltage analog of the high voltage current (1 V = 0.5 A) for the monitor circuits on the control card.

4.2.3.6 High Voltage Supply Monitor Circuits - These circuits sense three critical voltage and current levels and, through level detectors in U2 on the HV control P.C. board, will cause a high level at the shutdown input at U1-9 if any parameter is at an unsafe level.

The +12 and -5 V supply voltages are monitored by comparing the inputs at U2-4 and U2-5. If the voltages drop below the preset level, the resulting low level at U2-2 will cause the HVSD bus line to go low. This low is inverted at U2-13 and applied to U1-9 which causes the power supply output to drop to zero.

The sum of the high voltage control and feedback voltages is applied to the inverting input at U2-8 and compared with a fixed voltage which is slightly greater than the highest normal error (approx. +4 V). If the sum voltage exceeds this level, a low is produced at U2-14, a second input to the high voltage shutdown bus.

The third monitored parameter is the emitter current of the switch transistors A1A2Q1 and A1A1Q1. The voltage analog of switcher current is developed across the 0.1-ohm common emitter resistor A1A1R1 and connected through low-pass filter (C28, R19, and a 10K resistor in network U4) to U2-1 on the high voltage control P.C. board. The filter prevents operation of the circuit from the turn-on spikes but does allow operation on a pulse-to-pulse basis of the main current waveform.

The voltage level at U2-7, which determines the point at which current limiting will take effect, is adjustable with the I LIM control R21. The output at U2-1, which goes low during the period that the main current pulse waveform is higher than the reference level at U2-7, is also connected to the high voltage shutdown bus. This signal also triggers the electronic switch within U1 (refer to para. 4.2.3.3), but due to the fact that it is a 3 to 5 usec pulse, the soft start capacitor does not have time to discharge fully. The result is that the output voltage of the supply drops only slightly, and current limit pulses occur at the shutdown input at a 40 KHz rate, preventing the output from going higher, but not shutting the supply completely off.

The high voltage shutdown bus consists of the wire OR'ed connection of all devices whose outputs (active low) affect operation of the supply. In addition to the three comparator outputs described above, the thermal switch A1A1S1 places a ground on the bus if the heat sink temperature exceeds 75 degrees C. The high voltage relay K1 also grounds the bus whenever the instrument is not in the RF ON mode to insure that the soft-start function is engaged.

At any time that the bus is at a low level, the LED indicator DS1 on the high voltage control P.C. board is lit. (Flashes during current limiting are too short in duration to be seen.)

The low on the bus is applied to the System Control Card via A3CR5 for indicator operation. A3CR5 is used to prevent the +12 V high level of the bus from being connected to the TTL gates on the System Control Card and still allows a low ($<$ 1 V) to be sensed.

4.2.4 RF Power Detection and Indication

The RF output of the oscillator is connected to the front panel RF OUTPUT connector through bi-directional detector Z1. The two outputs of Z1 at Z1-FOR and Z1-REF are DC voltages proportional to the forward and reflected power levels respectively. The two DC levels are applied to separate amplifiers on the Meter Amplifier P.C. board. The voltage proportional to reflected power, E_{pr}, is amplified by a factor which will produce a meter reading equal to the RF power (in watts). The output at Z1-REF is essentially linear over the normal operating range (0 to 10 mv), so that the amplifier only increases the voltage level (gain is linear). The slope of the output from Z1-FOR shifts at an RF level of about 50W, so that a linearization circuit is added to the output of the P.O. (Power Output) amplifier. This allows the RF POWER meter to read within specifications up to a level greater than 250 watts. Further slope changes of the output at Z1-FOR above 250 watts are not compensated for, so that RF POWER meter accuracy is degraded at power levels higher than 250 watts (the meter reads low).

The meter should not be used as an indication of true power without first being calibrated with an external meter.

On the Meter Amplifier P.C. board, the P.O. zero adjust resistor R7 and the P.R. (Power Reflected) zero adjust resistor R14 allow the circuits to be compensated for amplifier offset and signal line losses, thus making the RF POWER meter read correctly at low levels. Slope adjust resistor R19 sets the breakpoint for the P.O. amplifier to provide correct readings at high level outputs.

The amplified levels (P.O. and P.R.) at resistors R20 and R25 are applied to U1-3 and U1-2. This section of the IC acts as a voltage comparator, and the voltage at U1-1 goes low (-4.0V) whenever the reflected power exceeds the fraction of the output power determined by R20 and R28. At an output power level of 250 watts, this fraction represents a VSWR of 1.5:1. At lower levels, the maximum allowable VSWR is proportionately higher. A constant ratio rather than a constant VSWR is used, since the oscillator can safely operate into greater mismatches at lower output levels.

The low level at U1-1 is connected to the digital card cage for use in remotely controlled systems. (This output is not used for front panel indications.)

The same two signals, P.O. and P.R., are also applied to U1-12 and U1-13 through divider network R24 and R41. If the voltage level at U1-13 exceeds the voltage at U1-12,a low level will appear at U1-14 and is applied to the VSWR shutdown circuit in the digital card cage.

Diodes CR2 and CR3 prevent the negative voltages from being connected to the TTL inputs on the System Control P.C. Board.

ADD TO PAGE 4-24

4.2.5 High Voltage Switch Board

The high voltage (0 to -2000 VDC) output of the power supply is connected to the board at E1. The path for the high voltage is through the series combination of R1 and R2 and out of the board at E2. From this point it goes to the plug-in unti via the filament transformer secondary.

Certain cavities require a lower series resistance for maximum efficiency and in these cases, K1 is energized providing a low impedance path in parallel with R2. The determination whether to energize K1 or leave it e-energized is made automatically when a plug-in is installed in the unit. High or low logic levels on the Plug-In Ident lines (each plug-in has a unique code) are decoded by CR2, CR3, and U1 on the High Voltage switch board to control operation of K1. R7 and R6 form a voltage divider which produces a +2V reference for voltage comparator U1.

When the voltage level on the 2^2 line is less than the reference voltage (logic 0), the output at U1-   will be high. A 2^2 voltage of greater than the reference voltage will cause a low level output. Since the outputs of both sections of U1 (Pins   and   ) are connected in an OR (low level) configuration, a low at either output will forward bias Q1 via R5 causing Q1 to conduct. Conduction of Q1 through the coil of K1 energizes the relay.

CR2 and CR3 from an AND gate allowing U1-   (inverting input) to go high only when both the 2^0 and the 2^1 lines are high. The following table defines the conditions of the Plug-In Ident lines which cause energization of K1.

Plug-In Ident			K1
2^0	2^1	2^2	Condition
0	0	0	Open
1	0	0	Open
0	1	0	Open
1	1	0	Closed
X	X	1	Closed

0 = low logic level

1 = high logic level

X = dont care

Section V

MAINTENANCE

5.0 GENERAL

This section consists of electrical alignment and calibration procedures, subassembly replacement procedures, and a trouble-shooting guide.

Note

> The frequency settings given at various points in paragraphs 5.3 and 5.4 assume that a Model 4045 cavity oscillator is plugged into the High-Power CW Source. If a different plug-in is installed, refer to the Appendix for that plug-in to obtain correct frequency settings.

5.1 TEST EQUIPMENT REQUIRED

The following test equipment or equivalent is required for test and alignment of the EP250C Power Source.

EQUIPMENT	MFG/MODEL	CRITICAL PARAMETER
Digital Voltmeter (DVM)	Fluke	3-1/2 digit resolution minimum
Volt-Ohmmeter (VOM)	Hickock	reads at least 2 KV
Oscilloscope	Tektronix 545	Tr < 10 nsec
RF Load	Bird 8325	500 W, 50 ohm
Directional Coupler	Narda 3000 Series	200 to 700 MHz min. 500 W power min.
50-Ohm Attenuators	Narda 757C	50 dB attenuation including directional coupler
6 dB Attenuator	Narda 768-6 dB	50-ohm, 50-W min.
Type N Short	Narda 230-416	
Frequency Counter	Hewlett-Packard 52452 w/Prescaler	200-700 MHz Range
RF Power Meter	Hewlett-Packard 431C	Max input at least +10 dBm
RF Detector	Hewlett-Packard 423	10 MHz to 2.4 GHz
Variable Attenuator	ARRA AR3221	0 to 10 dB, 10 W

5.2 SYSTEM ALIGNMENT

5.2.1 Power Control Adjustments

a) Connect test equipment as shown in Figure 5-1.

b) Set MAIN POWER switch to ON and, during the time delay, check for:

1. +5 ± 0.25V at VR1-OUT
2. +12 ± 1V at VR2-OUT
3. -5 ± 0.25V at VR3-OUT
4. > -3.5V at F5-OUT (nearer center of Chassis)
5. > -3.5V at F6-OUT (nearer center of Chassis)
6. +8 to +11V at F1-OUT (nearer center of chassis)

CAUTION

If any of these voltages are out of specification, shut unit off and make necessary repairs.

c) Set frequency to approximately 300 MHz with FREQUENCY ADJ control.

Note

If a plug-in other than the Model 8045H is installed, select a frequency at which the maximum output power is high. See Figure 1 of the appropriate appendix.

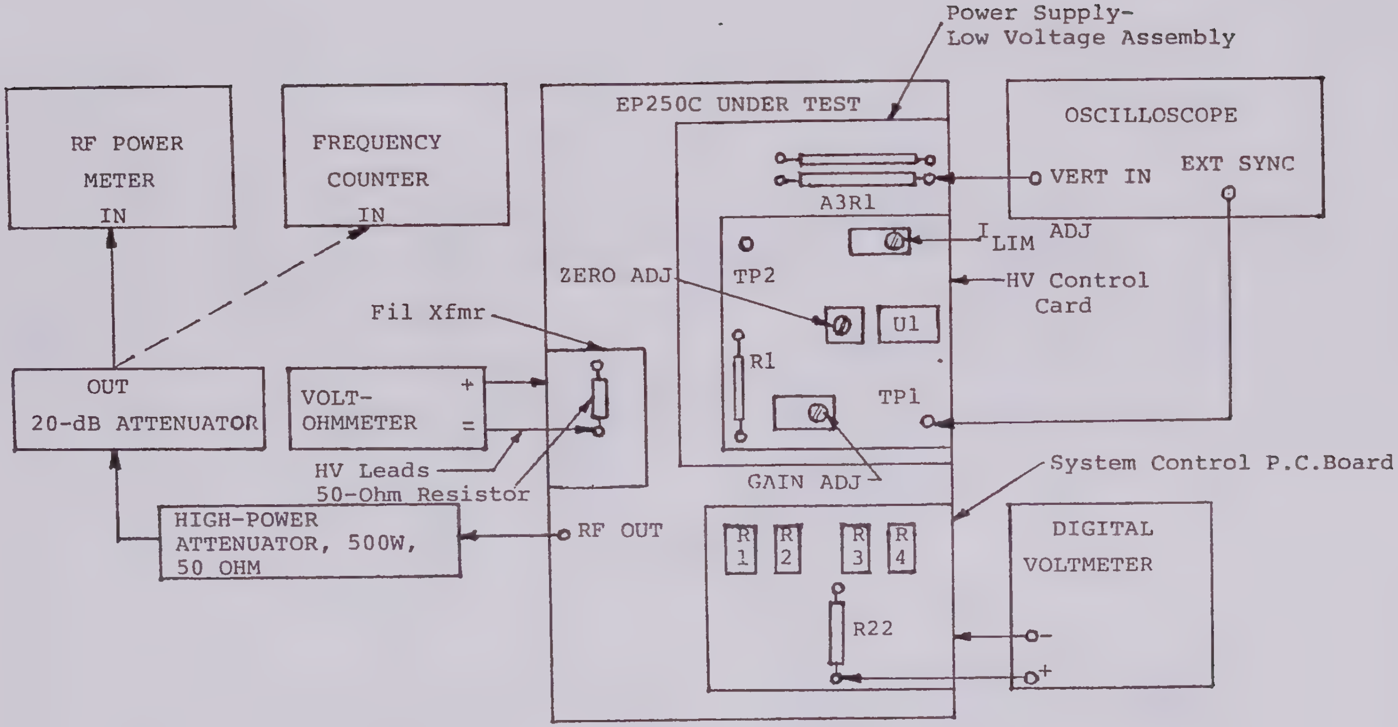
d) Set OUTPUT COUPLING control to mid-range.

e) Set ZERO control U5 on the high voltage control P.C. board in the power supply fully cw.

f) Set RF LEVEL ADJ fully ccw.

g) When STDBY lamp lights, depress RF switch.

h) Connect digital multimeter to input end of R1 on high voltage control P.C. board (input voltage TP on Figure 5-2). Adjust BALANCE resistor R1 on System Control Card for a reading of +2.5 VDC.


Power Supply-
Low Voltage Assembly
RF POWER
METER
IN
FREQUENCY
COUNTER
IN
EP250C UNDER TEST
OSCILLOSCOPE
VERT IN
EXT SYNC
A3R1
I_{LIM} ADJ
ZERO ADJ
TP2
HV Control
Card
U1
Fil Xfmr
R1
TP1
OUT
20-dB ATTENUATOR
VOLT-
OHMMETER
+
=
HV Leads
50-Ohm Resistor
GAIN ADJ
System Control P.C.Board
HIGH-POWER
ATTENUATOR, 500W,
50 OHM
RF OUT
R 1
R 2
R 3
R 4
DIGITAL
VOLTMETER
R22
-
+

R1 - BAL ADJ
R3 - Ip SENSOR ADJ
R4 - Ip DIFF ADJ

Figure 5-1. System Alignment Connections

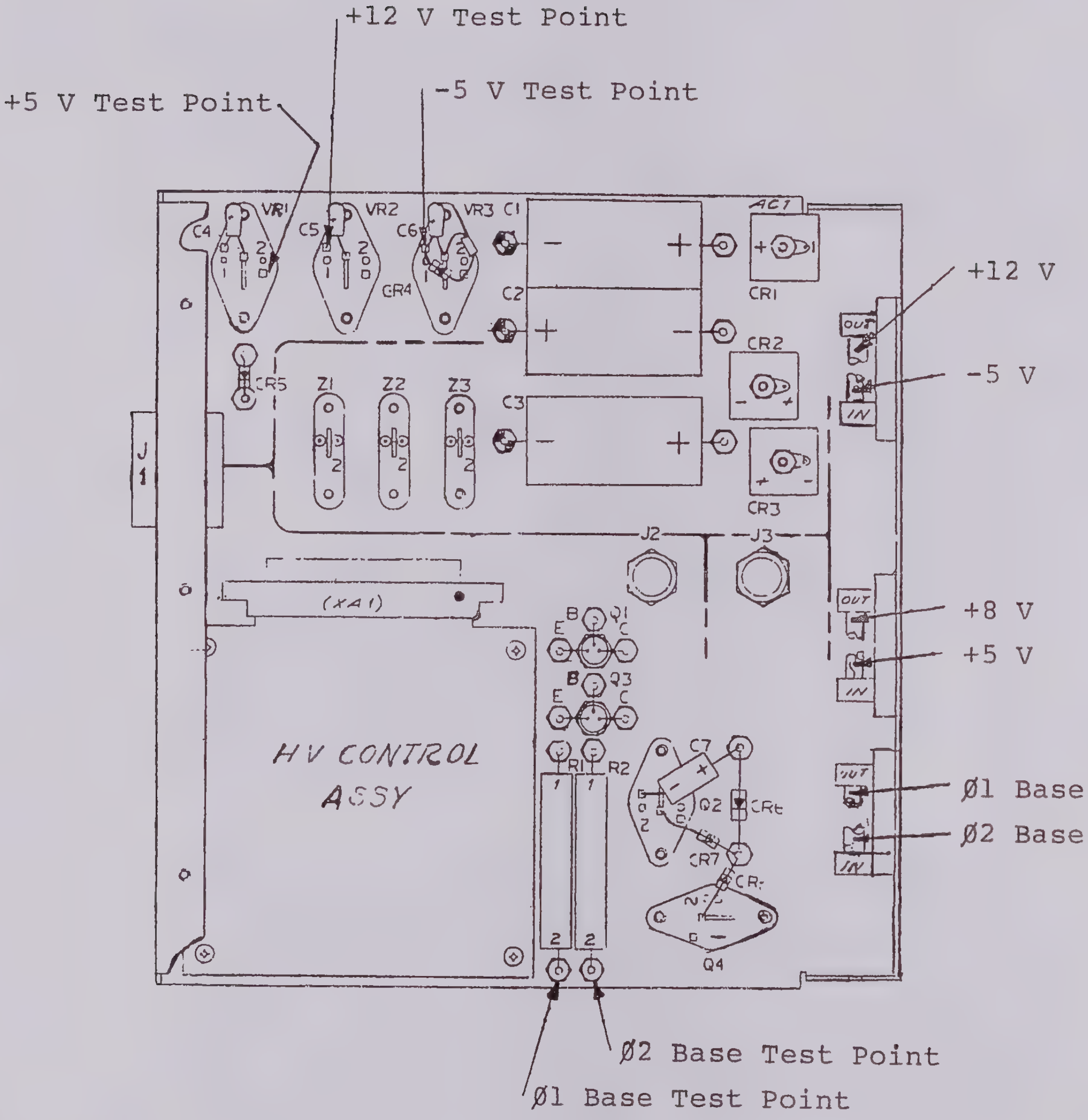

+12 V Test Point
+5 V Test Point
-5 V Test Point
VR1
VR2
VR3
C1
C2
C3
C4
C5
C6
CR4
AC1
CR1
CR2
CR3
CR5
Z1
Z2
Z3
J1
J2
J3
(XA1)
HV CONTROL ASSY
Q1
Q3
B
E
C
R1
R2
C7
Q2
CR6
CR7
CR8
Q4
OUT
IN
+12 V
-5 V
+8 V
+5 V
Ø1 Base
Ø2 Base
Ø2 Base Test Point
Ø1 Base Test Point

Figure 5-2. Low Voltage Assembly Test Points

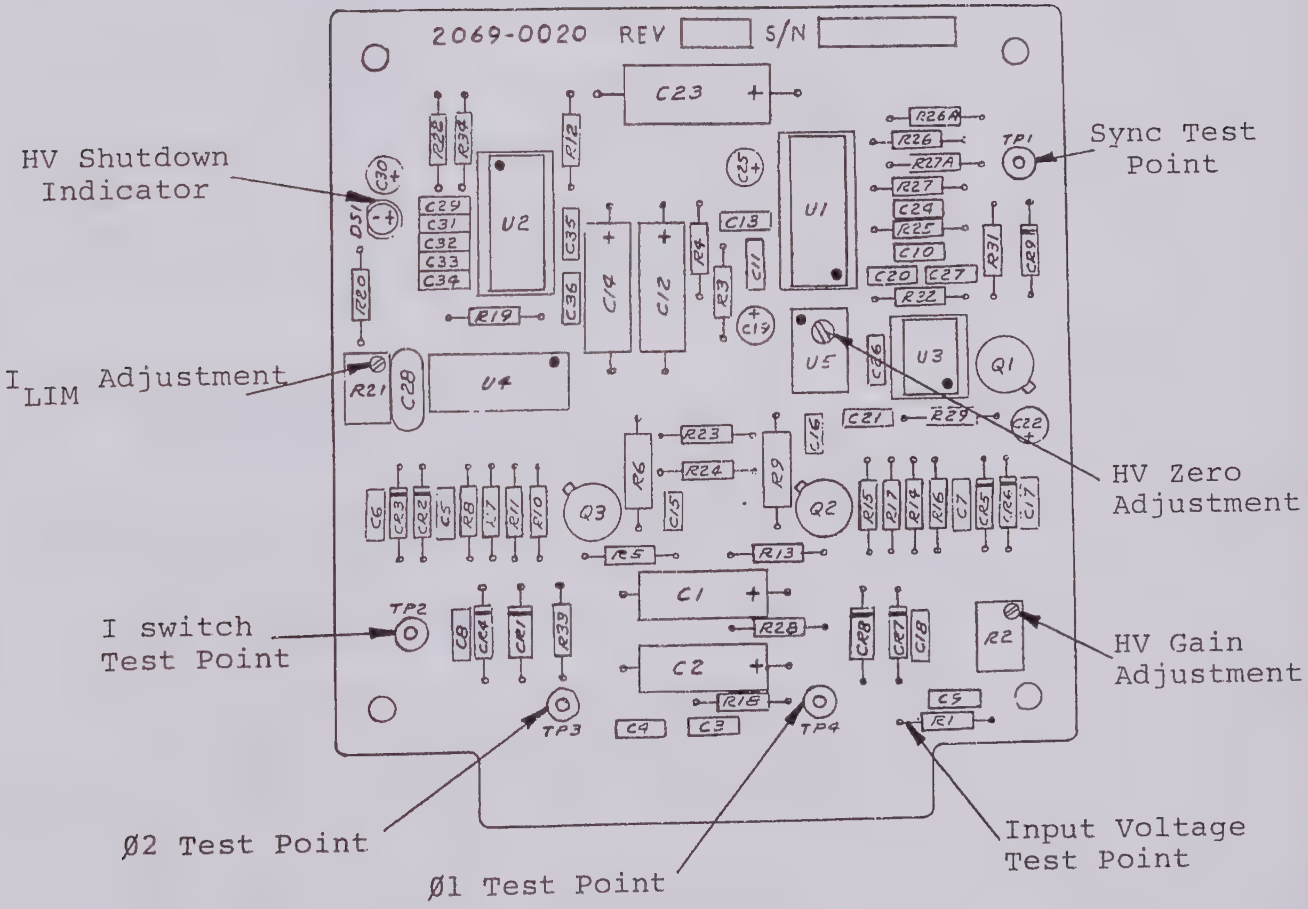

2069-0020 REV S/N
HV Shutdown Indicator
Sync Test Point
ILIM Adjustment
HV Zero Adjustment
I switch Test Point
HV Gain Adjustment
Ø2 Test Point
Ø1 Test Point
Input Voltage Test Point
TP1
TP2
TP3
TP4
DS1
R21
R2
U1
U2
U3
U4
U5
Q1
Q2
Q3
C23
C1
C2

Figure 5-3. High Voltage Control Assembly Adjustments and Test Points

i) Connect oscilloscope to outer end of R1 on Low Voltage Assembly (01 Base TP on Figure 5-3).

j) Turn ZERO control U5 ccw until a positive pulse appears on the oscilloscope, then turn it cw until the pulse just disappears. Be sure the pulse is fully off, not just very narrow.

k) Rotate RF LEVEL ADJ slowly cw and check that signal reappears within one-quarter turn of control. Readjust ZERO control if necessary.

l) Connect vertical input of oscilloscope to TP2 (I switch TP on Figure 5-3) on high voltage control P.C. board.

m) Rotate RF LEVEL ADJ to its fully cw position while viewing current wave form. Check that current maximums do not exceed 30 amperes (1V=10A). See Figures 5-4 and 5-5.

CAUTION

Turn on/turn off spikes on current wave form must not exceed 150 amperes in amplitude or 1 usec in width.

n) With the RF LEVEL ADJ control fully cw, adjust HV GAIN ADJ R2 on high voltage control P.C. board for an output voltage of 2,000 VDC as indicated on the volt-ohmmeter.

o) If the maximum duty cycle (see Figure 5-4) is reached and output is not at the 2,000V level, rotate OUTPUT COUPLING control slightly in a ccw direction to reduce coupling.

Note

If MAIN POWER lamp flashes before reaching maximum cycle, adjust I_{LIM} ADJ resistor R21 on high voltage control P.C. board cw until light remains lit.

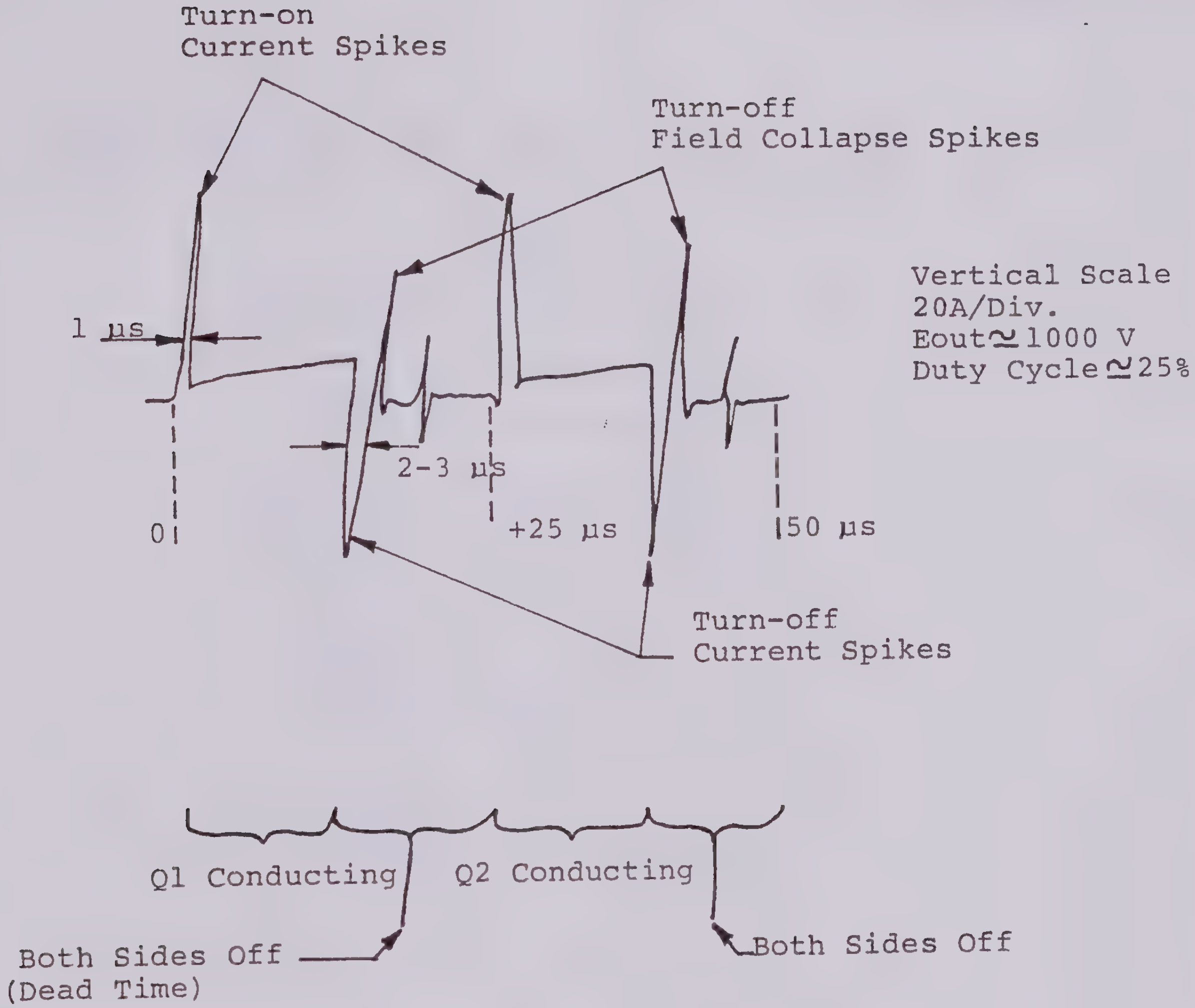

Turn-on
Current Spikes
Turn-off
Field Collapse Spikes
Vertical Scale
20A/Div.
Eout≃1000 V
Duty Cycle≃25%
1 µs
2-3 µs
0
+25 µs
50 µs
Turn-off
Current Spikes
Q1 Conducting
Q2 Conducting
Both Sides Off
(Dead Time)
Both Sides Off

Figure 5-4. Low Power Current Waveforms

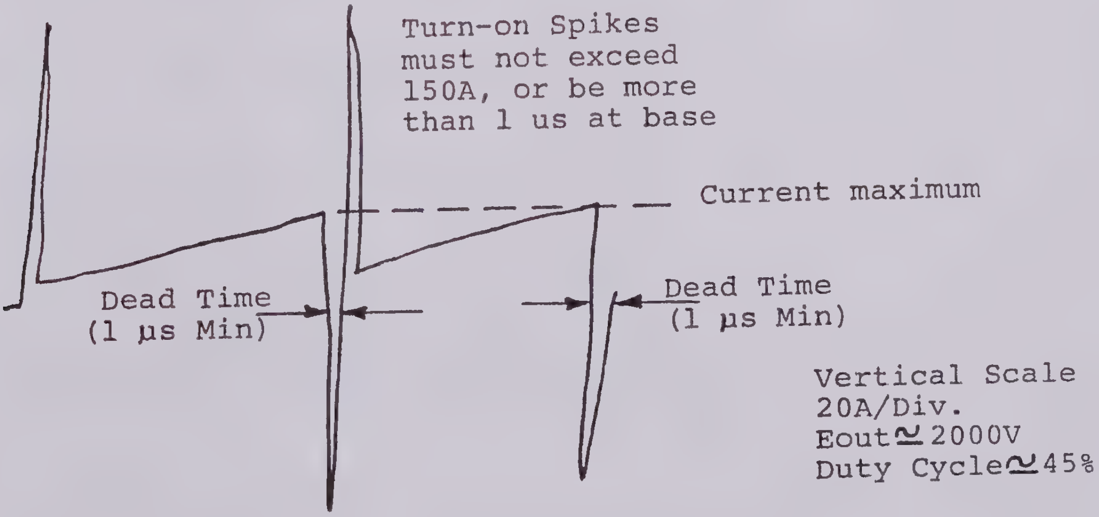

Turn-on Spikes
must not exceed
150A, or be more
than 1 us at base
Current maximum
Dead Time
(1 µs Min)
Dead Time
(1 µs Min)
Vertical Scale
20A/Div.
Eout≃2000V
Duty Cycle≃45%

Figure 5-5. Maximum Power Current Waveforms

p) Check that the shortest dead time (See Figure 5-5) is between 1 and 2 usec. The difference between dead times should be less than 1 usec.

CAUTION

Dead times of less than 1 usec can lead to premature failure of switching transistors.

q) To readjust dead time:

1. Shut down unit and replace dead time "tweaking" resistor R27A (on the high-voltage control P.C. board) with a 250- to 500-ohm (maximum) variable resistor.

2. Set the variable resistor so that parallel resistance of R27 and the variable resistor is approximately 150 ohms.

3. Check for an output pulse train at SYNC test point TP1 and, if necessary, reduce the resistance of the variable resistor slightly until the signal appears.

4. Return the unit to the condition in step p).

5. Carefully adjust the variable resistor until the shorter dead time is within the specifications described in step p).

6. Turn the unit off and measure the resistance of the variable resistor.

7. Install a fixed resistor (RN55C type) of the nearest value in place of R27A.

8. Recheck dead time after the new R27A is installed.

r) Connect the digital voltmeter to the bottom of R22 on the Control Card. See Figure 5-6 for location.

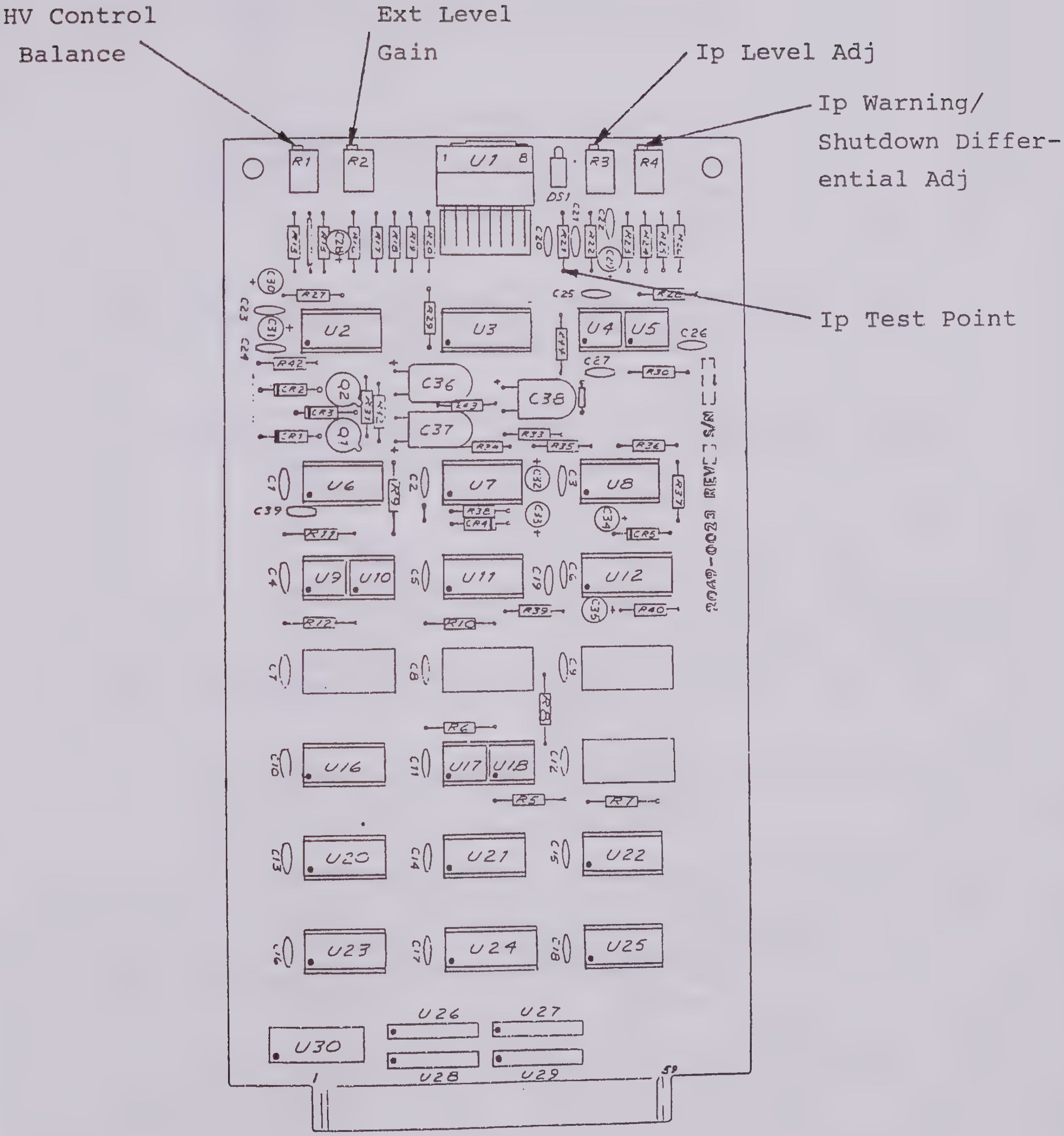

HV Control Balance
Ext Level Gain
Ip Level Adj
Ip Warning/ Shutdown Differential Adj
Ip Test Point
R1
R2
U1
DS1
R3
R4
U2
U3
U4
U5
C36
C37
C38
Q1
Q2
U6
U7
U8
U9
U10
U11
U12
U16
U17
U18
U20
U21
U22
U23
U24
U25
U26
U27
U28
U29
U30
2049-0023 REV[ ] S/N
1
59

Figure 5-6. System Control Card - Test Points and Controls

s) Set the frequency to approximately 475 MHz and adjust the output coupling for maximum output power. Note digital voltmeter reading.

Note

If a plug-in other than the Model 8045H is installed, choose a frequency at which the maximum output power is lowest. Refer to Figure 1 of the appropriate appendix.

t) Adjust I LIM ADJ (R21 on the high-voltage control board) until the main power lamp flashes, then back off until the lamp stops flashing (remains on steady).

u) Carefully increase the coupling until the digital voltmeter reading increases by 10 percent or reaches 0.800 mv (Ip = 0.4 amperes), whichever is lower.

Note

1 mv = 0.5 ma of cavity anode current.

v) Adjust Ip warning resistor (R3 on the system control card) until the Ip warning light flashes dimly.

w) Increase the coupling further until the digital viltmeter reads 1.000 VDC. Anode current is now 0.5 A.

x) Adjust IpSD resistor R4 on the system control card until Ip shutdown occurs.

y) Repeat steps u through x until Ip warning and Ip shutdown occur at the correct current levels.

5.2.2 RF Power Meter Adjustment

Note

The meter amplifier is part of the plug-in cavity assembly and this procedure must be performed for each plug-in oscillator.

a) Shut MAIN POWER switch OFF, wait at least 15 seconds, then set MAIN POWER switch to ON.

b) Adjust PO ZERO (R1 on meter amplifier P.C. board) until front panel meter reads 000 or 001. See Figure 5-7 for location.

c) Depress METER SEL switch and adjust P.R. ZERO (R2 on the meter amplifier P.C. board) until the front panel meter reads between -0.1 and -0.5.

d) Turn the instrument off and on several times and check that VSWR and/or RESET lamps do not light when power is first applied. Readjust PR ZERO to a more negative value if necessary. If it is necessary to go more negative than -0.9, a problem exists in the meter amplifier, meter, or wiring, and must be corrected.

e) Set the frequency to 400 MHz if 8045H plug-in is installed. Set to center of frequency range for other plug-ins.

f) Allow the instrument to "time in"; set the RF level for an output of 250 watts (maximum rated power for plug-ins other than the 8045H) as read on the external power meter. Allow for losses in cable and/or directional coupler.

g) Adjust the PO slope R3 on the meter amplifier board for a reading of 250 on the front panel meter.

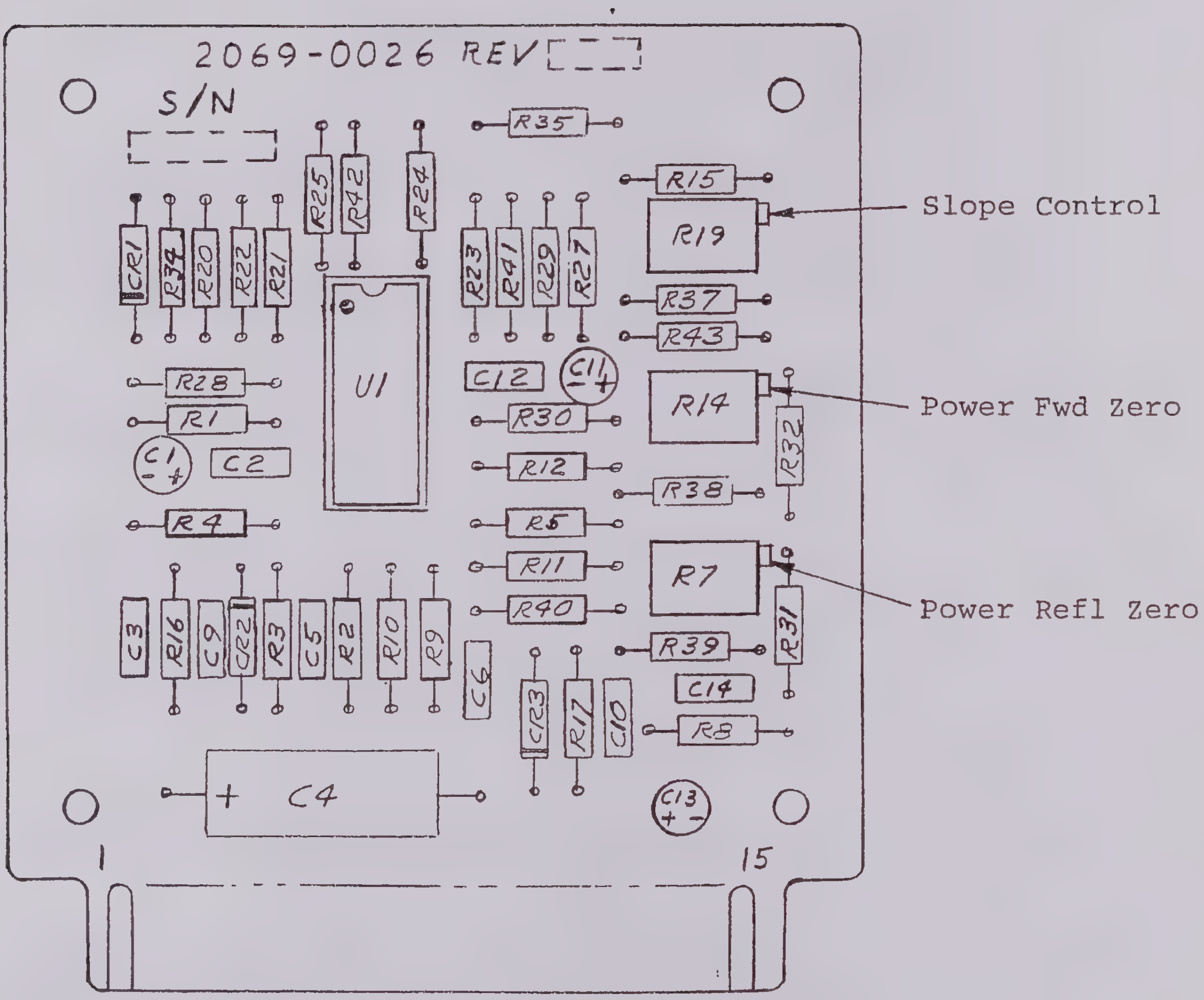

2069-0026 REV
S/N
R35
R25
R42
R24
R15
R19
Slope Control
CR1
R34
R20
R22
R21
R23
R41
R29
R27
R37
R43
U1
C12
C11
R28
R1
R30
R14
Power Fwd Zero
R32
C1
C2
R12
R38
R4
R5
R11
R7
Power Refl Zero
R40
R31
C3
R16
C9
CR2
R3
C5
R2
R10
R9
C6
CR3
R17
C10
R39
C14
R8
C4
C13
1
15

Figure 5-7. Meter Amplifier Controls

5.2.3 VSWR Detector Adjustment

a) Connect test equipment as shown in Figure 5-8.

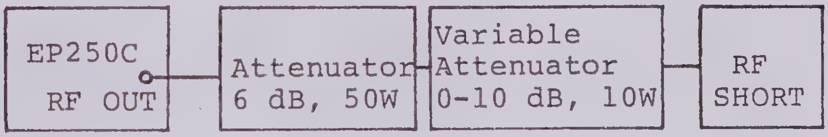


Figure 5-8. VSWR Test Connections

b) Connect a digital voltmeter to pin N of the Meter Amplifier Assembly connector. Expect readings of 0 to 10 mv.

c) Connect a volt-ohmmeter to pin L of the Meter Amplifier Assembly connector. Expect readings of approx. +4 VDC or -0.5 VDC.

d) Set the Variable Attenuator to maximum attenuation.

e) Set EP250C controls to obtain a reading of 50W as indicated on the RF POWER meter.

Note

> The RF POWER meter displays the voltage (in millivolts) at pin C of the Meter Amplifier Assembly connector (i.e., 50W = 0.050 V = 50 mv).

f) The volt-ohmmeter should read approximately +4 VDC.

g) Reduce the setting of the Variable Attenuator until the volt-ohmmeter reading switches to a slightly negative value.

h) The ratio of the digital voltmeter reading/RF Power Meter reading should be 0.05 ± 0.005.

i) Select a new resistor for R28 (on the Meter Amplifier Assembly) if not within limits (higher value to lower ratio).

j) Continue to decrease the setting of the Variable Attenuator until VSWR shutdown occurs.

Note

Digital voltmeter reading will drop to zero as soon as shutdown occurs. RF POWER meter reading at shutdown can be viewed by pressing the RESET switch.

k) The ratio of the digital voltmeter reading/RF POWER meter reading should be 0.07 ± 0.007.

l) Select a new resistor for R41 (on the Meter Amplifier Assembly) if not within limits (higher value to lower ratio).

5.3 OPERATIONAL CHECK

5.3.1 Test Setup

a) Set up the EP250C Power Source in its normal operating configuration with the plug-in oscillator installed.

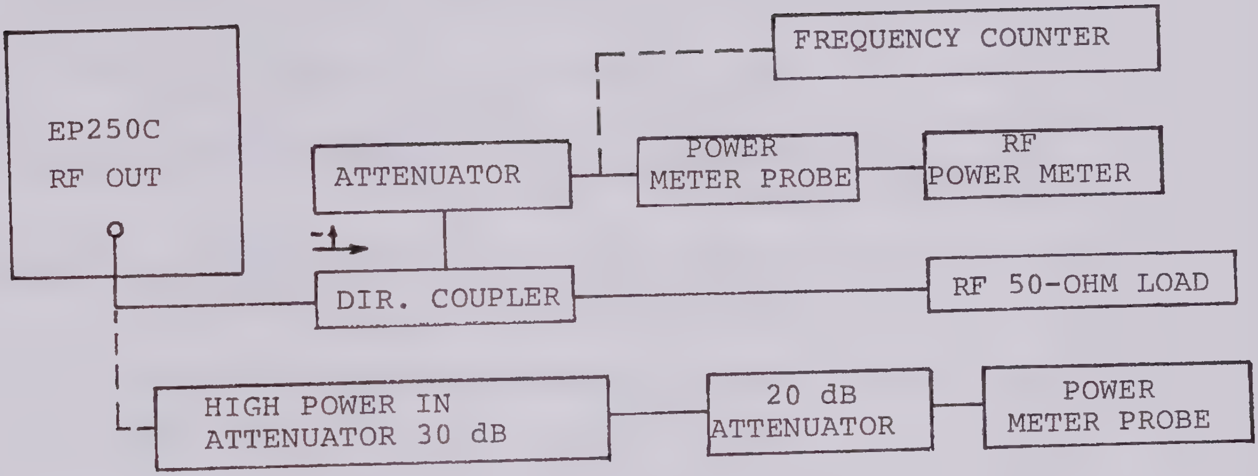
b) Connect the RF OUT terminal of the plug-in oscillator to a load through the directional coupler as shown in Figure 5-9.

c) Connect the RF Power Meter to the coupler through attenuators so that there is a total of 50 dB (including coupler) between the Power Meter detector and the signal path.

Note

Calibrate to find the exact loss between the RF OUT jack and the power meter. Add the calibration factor to all test readings.

d) Record the calibration factor.


FREQUENCY COUNTER
EP250C
RF OUT
ATTENUATOR
POWER METER PROBE
RF POWER METER
DIR. COUPLER
RF 50-OHM LOAD
HIGH POWER IN ATTENUATOR 30 dB
20 dB ATTENUATOR
POWER METER PROBE

- - - - - - - - Alternate Connection

Figure 5-9 Test Setup

e) Check that the power meter is accurately set at zero.

f) Remove the top cover from the instrument (if installed).

5.3.2 Test Procedure

5.3.2.1 Startup Test

a) Simultaneously set MAIN POWER switch on front panel to ON and start the timer.

b) Check that the main power indicator is lit.

c) Check that RF POWER meter reads 000 or 001 watt.

d) Press and hold the METER switch on the front panel to the REFL position and check that the meter reads -00.1 to -00.9.

e) Check that all other switches and indicator lamps are off.

f) As soon as the STDBY lamp lights, stop timer.

g) Check that time delay is 4 to 6.5 minutes.

h) With RF LEVEL ADJ set fully ccw, depress RF switch to test the RF ON circuit.

i) Check that RF lamp lights and STDBY lamp goes out.

j) Press the RF switch a second time. Check that RF lamp goes out and STDBY lamp lights. This step checks the RF OFF circuit.

k) Press RF switch; then press RESET switch.

l) Check that unit returns to STDBY mode (STDBY lamp on; RF lamp off).

5.3.2.2 Minimum Power Test

Note

For plug-ins other than the Model 8045H, use frequency and power ratings shown in the specifications for the particular plug-in from the appropriate appendix.

a) Set OUTPUT COUPLING control to mid-position (approximately).

b) Set FREQUENCY ADJ to 200 MHz (as read on the tuning dial).

c) Turn the RF LEVEL ADJ control fully cw.

d) Adjust OUTPUT COUPLING for maximum power on the RF Power Meter.

e) Check that power meter reading plus calibration factor is at least 225 watts.

Note

The Ip warning lamp and/or the MAIN POWER lamp may be flashing.

f) Repeat steps c through e at frequencies of 250 MHz to 700 MHz in 50-MHz increments.

5.3.2.3 Power Meter Accuracy Test

a) Set RF LEVEL ADJ fully ccw, and FREQUENCY ADJ to frequency producing maximum power. Refer to Figure 1 of appropriate appendix.

b) Adjust RF LEVEL so that the total of the power meter reading and calibration factor is equal to 20 watts.

c) Check that RF POWER meter reading equals 15.8 to 25.4 watts.

d) Adjust RF LEVEL ADJ so that power meter reading added to the calibration factor equals 100 watts.

e) Check that RF POWER meter reads 78.5 to 127.4 watts. Note reading.

f) Adjust RF LEVEL ADJ so that power meter reading added to the calibration factor equals 250 watts (maximum rated power for those cavities not rated at 250 watts).

g) Check that power meter reads 196 to 314 watts (maximum rated power ± 1.0 dB). Note reading.

5.3.2.4 Power Meter Repeatability Test

a) Set RF power to zero, then adjust until RF POWER meter reads the value noted in para. 5.3.2.3, step e.

b) Check that external power meter reading plus calibration factor is 100 ± 10 watts.

c) Adjust RF LEVEL ADJ until RF POWER meter reads the value noted in para. 5.3.2.3, step g. Check that external power meter reading Plus calibration factor is 250 ± 25 watts.

5.3.2.5 Frequency Test - Range

a) Set the RF LEVEL ADJ fully cw.

b) Set FREQUENCY ADJ fully ccw (below 200 MHz).

c) Replace the power meter probe and attenuators with the input to the Frequency Counter. See Figure 5-1.

d) Slowly increase the RF power setting until a stable frequency reading is obtained.

e) Check that the frequency counter reads 200 MHz or less.

f) Set FREQUENCY ADJ to upper limit (above 700 MHz).

g) Check that the frequency counter reads 700 MHz or higher.

5.3.2.6 Frequency Test - Resettability

a) Set frequency to exactly 400 MHz on the dial, making the final setting in an increasing direction.

b) Record the frequency counter reading.

c) Change the frequency reading by at least 100 MHz.

d) Reset frequency to exactly 400 MHz, making final setting in an increasing direction.

e) Check that reading is equal to reading in step b, ± 1 MHz.

5.3.2.7 Power Level Range Test

a) Set RF LEVEL ADJ fully ccw.

b) Set frequency to center frequency for plug-in operating range.

c) Carefully increase the setting of the RF LEVEL ADJ to the minimum necessary to obtain a stable frequency reading.

d) Replace the frequency counter with the power meter probe.

Note

It may be necessary to remove the low power attenuators (20 dB) to obtain a usable reading.

e) Check that the power meter reading is less than 10 percent of the reading recorded as the maximum power for this frequency (para. 5.3.2.2, step f).

5.3.2.8 Safety Shutdown Checks

a) Connect test equipment as shown in Figure 5-8. Set Variable Attenuator to maximum attenuation.

b) Adjust RF LEVEL ADJ for a reading of 50 watts on the RF POWER meter.

c) Depress and hold the METER switch in the REFL position and note the reading.

d) Hold the METER switch in the REFL position and adjust the Variable Attenuator until VSWR shutdown occurs.

e) Depress the RESET switch and check that the RF POWER meter reads 2.5 ± 0.5 watts higher than the reading noted in step c.

f) Connect the test equipment as shown in Figure 5-9.

g) Set the RF LEVEL ADJ fully ccw

h) Set the frequency to a value where the maximum output power is lowest (see Figure 1 of the appropriate appendix).

CAUTION

Rapid increases in coupling (against the maximum coupling stop) may cause power supply shutdown due to high instantaneous switcher currents.

i) Slowly increase (turn cw) the OUTPUT COUPLING adjustment and check that the Ip warning lamp flashes.

j) Continue to increase the coupling until Ip shutdown occurs.

k) Check that Ip indicator light is lit constantly and that the RESET light flashes.

l) Reset the unit and obtain a power level of approximately 100 watts as indicated on the RF POWER meter.

m) Use a clip lead to short the normally-open terminal of the 175-degree thermostat (on the cavity body) to ground.

n) Check that the TEMP light flashes and goes out when the short is removed.

o) Short the normally-open terminal of both thermostats to ground (175-degree thermostat first, 185-degree thermostat last).

p) Check that the TEMP indicator is lit and that the RESET indicator flashes.

5.4 REPLACEMENT OF ASSEMBLIES

The following procedure is used to gain access to the interior of the instrument and must be completed before any internal assembly can be removed and/or replaced.

a) Be sure that the MAIN POWER switch on the front panel is set to OFF and that the power cord is disconnected from the power source.

b) Disconnect the twist-lock connector holding the cord to the back panel of the instrument. Apply slight pressure to the connector and turn one-quarter turn ccw to release.

c) Remove the six screws holding the front panel to the outer case and pull the unit forward on its slides until both slide catches are closed.

Note

In bench-top installations, access to the inner case cover can be gained by removing the top cover of the outer case.

d) Remove the nine screws holding the large inner cover in place, and remove the inner case cover.

Note

It is necessary to remove the rear (short) cover only to access the blower, the blower relay, and/or the input line filter.

e) Repeat the preceding steps in the reverse order to return the unit to operating condition after service.

5.4.1 Digital Card Replacement

To remove the card:

a) Hook the two fingers of the card extraction tool (stored in a clip on the inside of the instrument cover) into the two holes at the top edge of the circuit board.

b) Pull upward with a slight rocking motion until the card edge fingers are released from the connector, then pull straight up to remove the card.

To re-install the card:

a) Align the card edges with the card guides. Be sure the component side of the card is facing the outside of the instrument.

b) Press down firmly until the card is fully seated in the connector.

5.4.2 Digital Card Cage Replacement

a) Disconnect the plugs from J1 and J3 (at the front and rear of the cage) by pulling with a rocking motion. DO NOT PULL BY THE CABLE.

b) Disconnect the plug from J2 by compressing the sides of the connector (to release the latches), then pull straight up.

c) Tip the instrument on its side and remove the four screws holding the card cage to the bottom chassis.

d) With the unit right-side up, carefully lift the cage free of the box, taking care that the protrusions do not catch on cables.

To re-install the subassembly, follow the preceding steps in the reverse order.

5.4.3 Power Supply Replacement

a) Disconnect the plugs from J1, J2, and J3, and move the cables toward the front of the instrument to clear the power supply mounting flanges.

b) Loosen the four captive screws holding the power supply to the bottom of the case.

c) Use the fingernail slots to pull the two handles (on the sides of the power supply) up to their lifting position.

WARNING

> The power supply weighs in excess of 50 pounds; before attempting to lift it, be sure to be properly positioned to complete the lift in one motion without personal injury.

d) Lift the supply straight up until it clears the case, taking care that the mounting flanges do not catch on other chassis-mounted components.

To re-install the power supply, follow the preceding steps in the reverse order.

Note

> The two large holes in the mounting flanges of the power supply must fit over the guide posts located on the bottom of the chassis for correct alignment.

5.4.4 Front Panel Removal

To facilitate maintenance, it may be convenient to temporarily remove the front panel. Proceed as described in the following steps.

a) Remove the plug-in oscillator.

b) Remove the four screws holding the handles to the front panel.

c) Remove the six nuts, flat washers, and lock washers (located at the bottom center of the bottom and top centers of the control compartment, the plug-in compartment, and at the center wall flange-control compartment side).

d) Tip the top of the front panel forward to obtain access to its rear side.

e) For complete removal of the panel:

  1. Disconnect P1 from the connector on the Digital Card Cage.
  2. Disconnect the power line connector P1J2.
  3. Disconnect the two wires (Fast-on connectors) at TB1-6 and TB1-14 (red and black wires leading to the main chassis).

CAUTION

When re-installing the panel, be sure that the red lead is connected to TB1-6 and the black lead to TB1-14. Press firmly for proper connections.

5.5 REMOVAL OF POWER SUPPLY SUBASSEMBLIES

5.5.1 Accessing Power Supply Components

Access to the Power Supply components is gained by performing the following steps.

a) Remove the three screws on the top front edge of the cover.

WARNING

Voltages capable of producing serious injury or death on contact are present in the power supply during its operation.

Note

> The hinged top cover may be lifted to its open position for access to components in the low voltage and high voltage control circuit areas without further disassembly.

b) Remove the three screws holding the front screen to the low voltage assembly.

Note

> The low voltage assembly may be lifted on its hinges for access to components in the high voltage area for testing or fuse replacement without further disassembly.

To allow removal of major subassemblies, continue with steps c through g.

c) Remove the seven screws holding the front screen in place; remove the screen and set aside.

d) Remove the seven screws holding the rear screen in place; remove the top screws last to prevent the screen from bending.

e) Carefully lift the screen clear, far enough to reach the fan connector.

f) Disconnect the fan connector and set the screen aside.

g) To reinstall the components, reverse the order of these steps.

5.5.2 Removal of High-Voltage Card

Remove the High-Voltage Card as described in the following steps.

a) Perform step a) of paragraph 5.5.1.

b) Remove the four screws holding the board to the chassis.

c) Lift the board and connector until the connector can be grasped and removed without applying undue strain on the cable.

d) To reinstall, reverse the order of these steps.

5.5.3 Replacement of Components on Bottom of Low-Voltage Chassis

To replace components on the bottom of the Low-Voltage chassis, continue as described in the following steps.

a) Perform steps a) and b), paragraph 5.5.1.

b) With chassis in the vertical position, remove the two self-tapping screws holding the component in place.

c) Pull the component from its socket.

d) To install replacement, reverse the order of these steps.

CAUTION

When replacing Q2, Q4, VR3, or Z3, be sure an insulating pad is installed between the component and the chassis.

If a mica insulator is used, apply thermal compound during installation.

In all cases, be sure bosses on sockets are aligned with holes in chassis.

5.5.4 Replacement of High-Voltage Module

Note

The two power transistors, Q1 and Q2, may be replaced without removing the high-voltage module. See paragraph 5.6 .

a) Complete all steps of paragraph 5.5.1 .

b) Disconnect the two leads from the low-voltage module (the red lead at F1, the Faston connector; the black lead at C1- (-)).

c) Disconnect the plug from J2 on the bottom of the low-voltage assembly.

d) Lay the power supply on its side (high-voltage module down), and remove four screws holding the high-voltage module in place.

e) Return the power supply to its upright position and slide the high-voltage module out through the rear opening.

f) Follow steps in reverse order to install module.

5.5.5 Replacement of Low-Voltage Chassis Assembly

a) Perform steps a) and b) of paragraph 5.5.1 .

b) Tilt the top cover and low-voltage assembly up and disconnect P1 and P2 from the bottom of the chassis.

c) Return the low-voltage assembly to its normal operating position and remove the two hinge bolts holding the top cover and the low-voltage assembly to the power supply chassis side walls.

d) Remove the top cover then remove the low-voltage assembly.

e) To replace the assembly, follow these steps in reverse order.

5.5.6 Replacement of Low-Voltage Module

a) Complete the procedures of paragraph 5.4.1 .

b) Disconnect the red leads to the high-voltage module at F1, the Faston connector.

c) Remove the two leads from C1- (-) connector.

d) Remove all leads from C1- (+) connection except the lead to F1.

e) Press the sides of AC Input connector J3 to release it from the chassis. Remove J3 and attached wires to the rear of the supply (through the center opening).

f) Disconnect P1 from J2 on the low-voltage chassis assembly.

g) Unsolder leads from T1-11 and T1-15 and move leads aside.

h) Lay the power supply on its side and remove four screws holding the low-voltage module to the bottom of the chassis.

i) With the supply in the upright position, slide the low-voltage module out through the rear of the supply.

j) To re-install the module, follow these steps in the reverse order.

5.5.7 Replacement of Switching Transistors

a) Remove rear screen assembly.

b) Using a short, Phillips-head screwdriver inserted through the access holes in the side of the chassis, remove the two screws holding Q1 in place (use long-nose pliers to hold attaching nuts).

c) Use the same technique to remove the screws holding Q2 in place (access holes in air duct are located over screw heads).

d) Remove clip-on heat sink from the case of the transistor, if installed.

e) Using a slotted screwdriver blade, carefully pry transistors Q1 and Q2 loose from their sockets. Take care not to damage insulating pads.

Note

The sockets are held in place only by the transistor mounting screws and will pull out from the heat sink when the transistors are removed.

f) Remove Q1 and Q2 from the assembly through the rear opening (a pair of long-nose pliers makes a convenient handling tool).

g) Carefully examine the Sil-pad insulators and replace if any burned spots exist.

Note

TO-3 style mica insulators may be used in place of the Sil-pad insulators. Thermal compound must be used when reassembling mica insulators; the compound is not necessary if Sil pads are used.

h) Using long-nosed pliers, position the replacement transistor over the mounting holes in the heat sink and start the screws in place.

Note

Q1 is mounted with the base and emitter pins toward the bottom; Q2 is mounted with the base and emitter pins toward the top.

i) Align the transistor socket so that bosses fit into holes in the heat sink; hold in place while pressing transistor pins into the holes in the socket. Considerable pressure is required to seat transistor properly.

j) Install the clip-on heat sink (if used in particular supply).

k) Install the mounting screws. Use long-nose pliers to start the screw and press into place through socket using screwdriver.

l) Place solder lugs over screws and install nuts.

CAUTION

To prevent shorting, be sure solder lugs are aligned so as to provide adequate clearance. Voltages up to 400 V are applied to these terminals.

m) Tighten mounting screws securely.

n) Repeat for second transistor.

o) Use ohmmeter to be sure that no short exists between the case and ground, case and emitter pins, or case and base pins.

5.6 TROUBLESHOOTING FLOW DIAGRAMS

The flow diagrams on the following pages are designed to assist the technician in diagnostic testing for faster repair thus minimizing instrument down time in the event of a malfunction.

To use the diagrams, find the START or test number point (sheets 1 through 21) that most closely describes the observed symptom, then follow the flow path. Conduct the tests described to determine the direction to proceed at each decision point.

Following the flow path will lead to the first replaceable subassembly which could affect a repair. The diagrams are not designed for troubleshooting and repair at the component level.

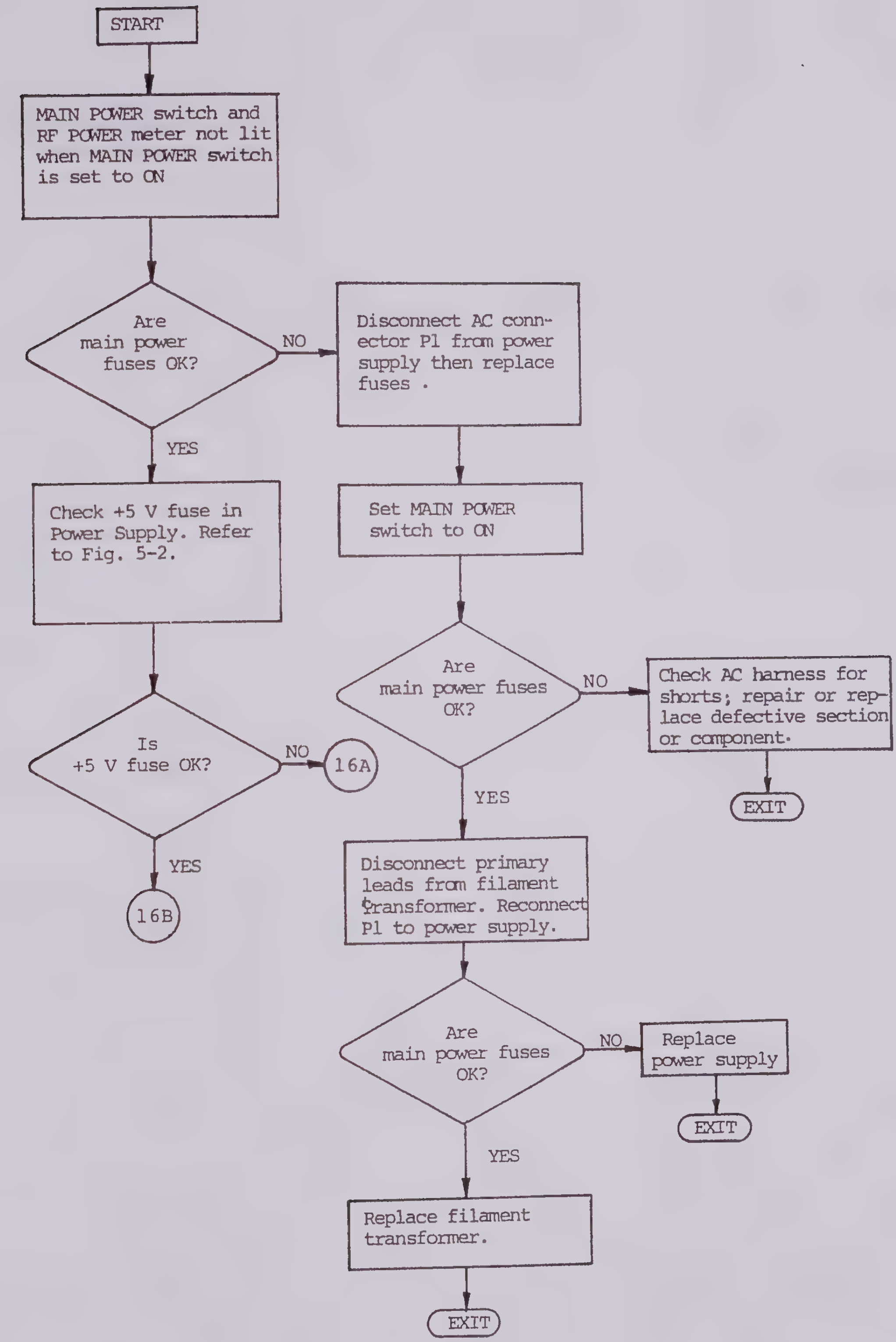
In some instances, the problem can be traced to a power supply subassembly using the flow diagrams. The decision as to whether to replace the module or the entire power supply depends on the standard practice at the using location.

To determine the specific component which is causing a problem, it is recommended that these diagrams be used first to find the defective subassembly. From that point on, a thorough knowledge of system operations, as described in paragraph 4.2, and alignment procedures (paragraph 5.2) will allow the use of normal signal tracing and/or component substitution troubleshooting procedures.

Note

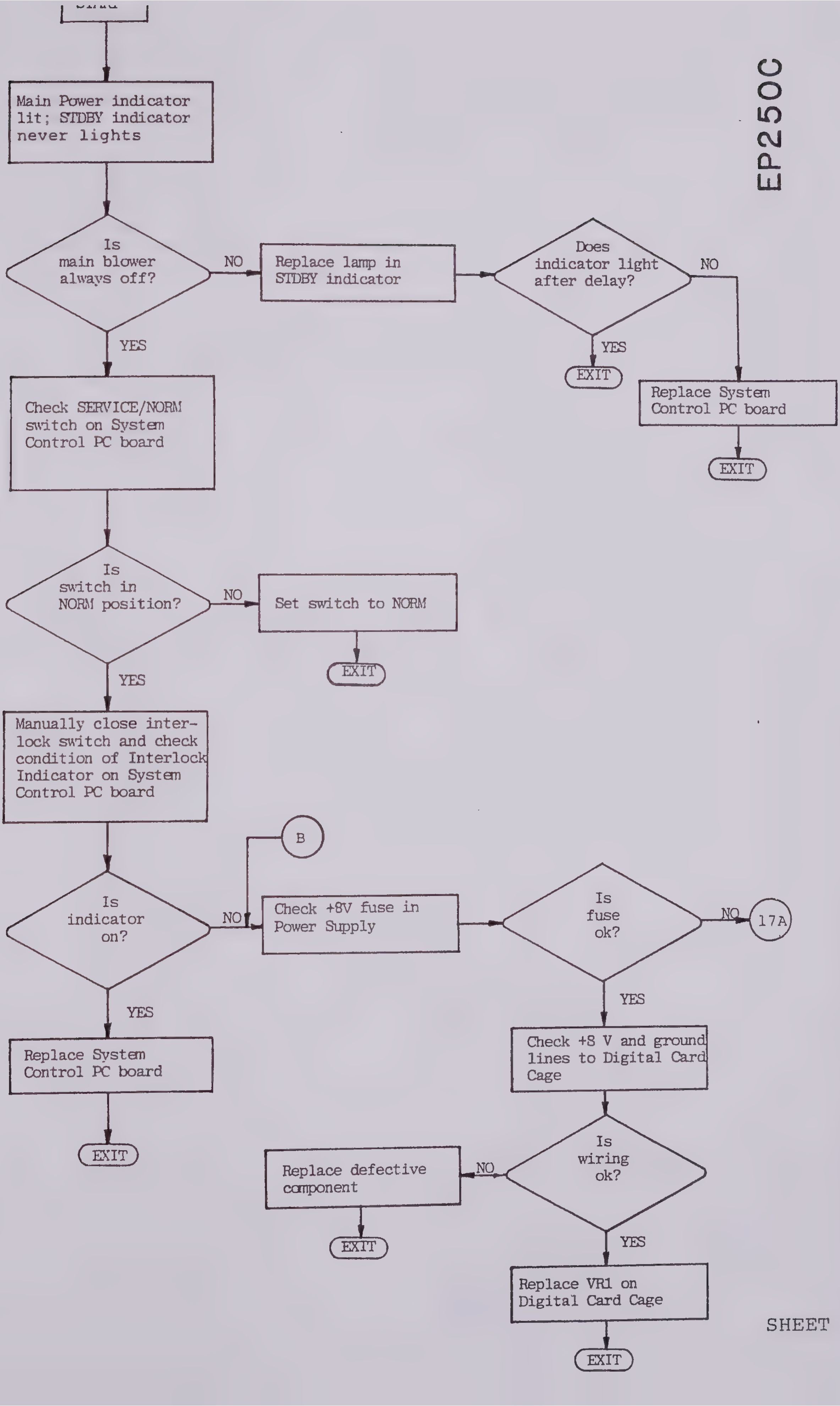
Although the following diagrams do not include specific instructions to turn system power on or off, it is expected that technicians performing the troubleshooting will be sufficiently experienced to perform the required actions at the appropriate point.

EP250C


START
MAIN POWER switch and RF POWER meter not lit when MAIN POWER switch is set to ON
Are main power fuses OK?
NO
Disconnect AC connector P1 from power supply then replace fuses .
YES
Check +5 V fuse in Power Supply. Refer to Fig. 5-2.
Set MAIN POWER switch to ON
Are main power fuses OK?
NO
Check AC harness for shorts; repair or replace defective section or component.
EXIT
Is +5 V fuse OK?
NO
16A
YES
16B
YES
Disconnect primary leads from filament transformer. Reconnect P1 to power supply.
Are main power fuses OK?
NO
Replace power supply
EXIT
YES
Replace filament transformer.
EXIT

TROUBLESHOOTING FLOW DIAGRAM

SHEET 1


Main Power indicator lit; STDBY indicator never lights
Is main blower always off?
NO
Replace lamp in STDBY indicator
Does indicator light after delay?
NO
YES
EXIT
Replace System Control PC board
EXIT
YES
Check SERVICE/NORM switch on System Control PC board
Is switch in NORM position?
NO
Set switch to NORM
EXIT
YES
Manually close interlock switch and check condition of Interlock Indicator on System Control PC board
B
Is indicator on?
NO
Check +8V fuse in Power Supply
Is fuse ok?
NO
17A
YES
Check +8 V and ground lines to Digital Card Cage
Is wiring ok?
NO
Replace defective component
EXIT
YES
Replace VR1 on Digital Card Cage
EXIT
YES
Replace System Control PC board
EXIT

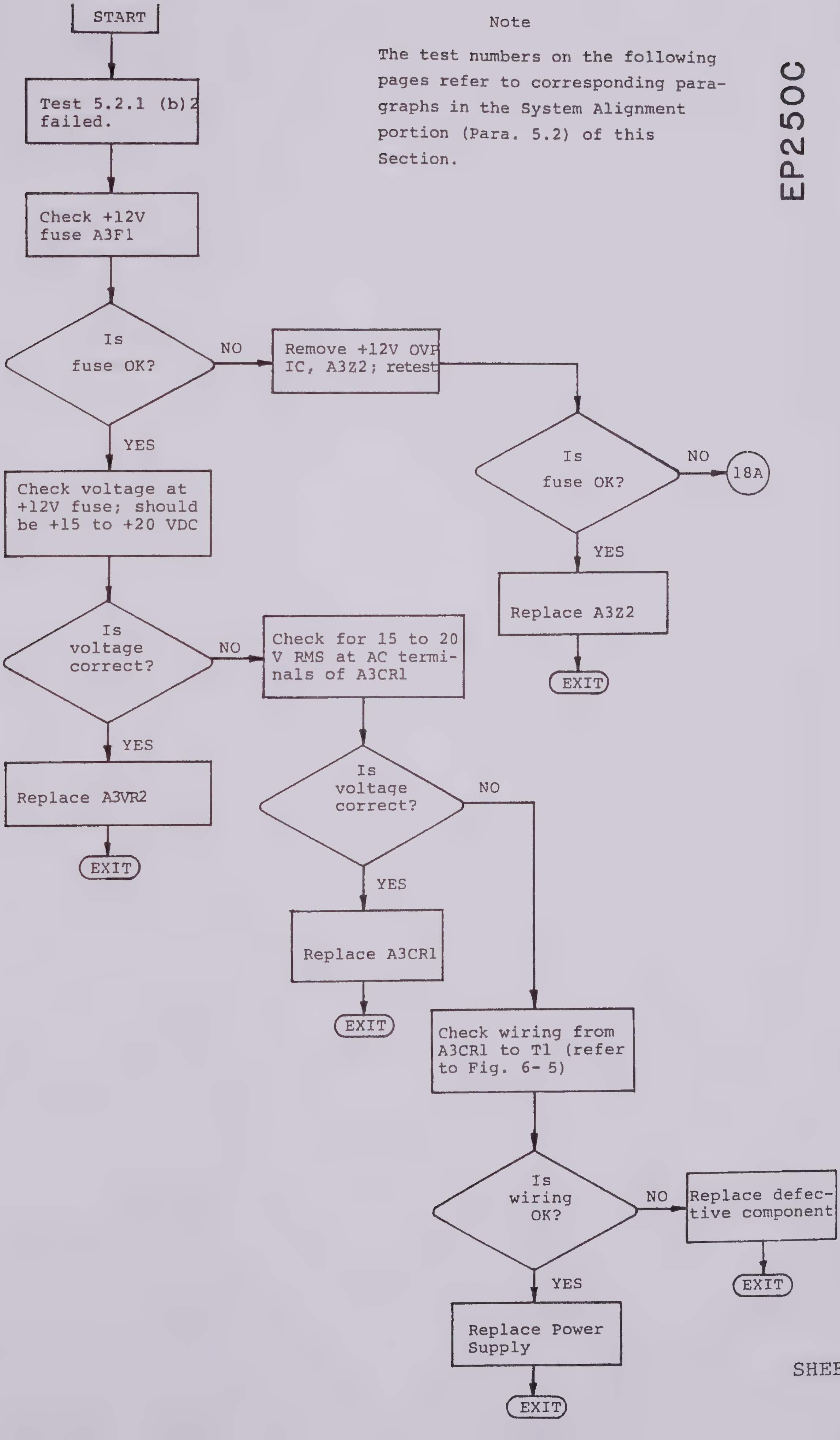
TROUBLESHOOTING FLOW DIAGRAM

SHEET 2

EP250C

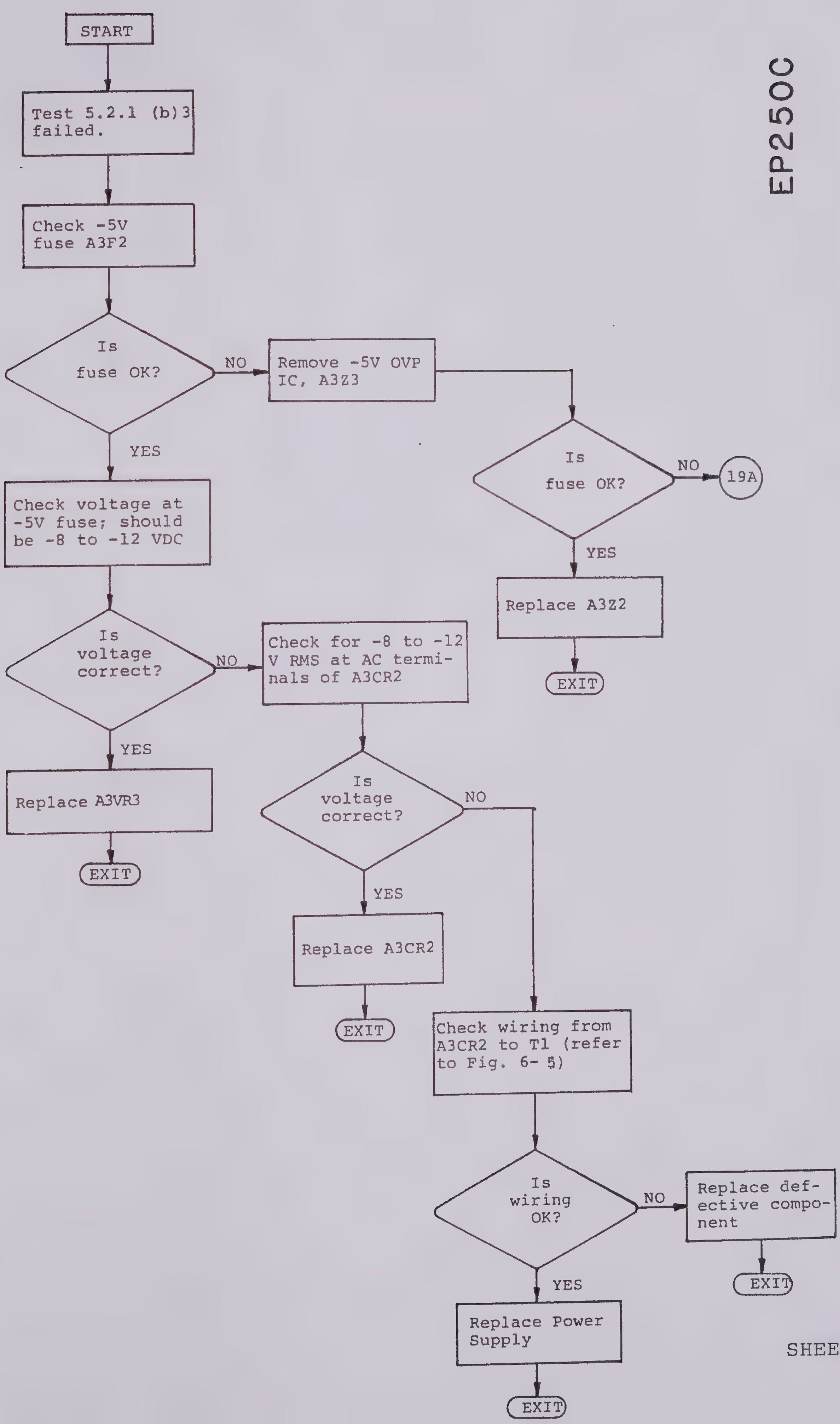
Note

The test numbers on the following pages refer to corresponding paragraphs in the System Alignment portion (Para. 5.2) of this Section.


START
Test 5.2.1 (b)2 failed.
Check +12V fuse A3F1
Is fuse OK?
NO
Remove +12V OVP IC, A3Z2; retest
Is fuse OK?
NO
18A
YES
Replace A3Z2
EXIT
YES
Check voltage at +12V fuse; should be +15 to +20 VDC
Is voltage correct?
NO
Check for 15 to 20 V RMS at AC terminals of A3CR1
YES
Replace A3VR2
EXIT
Is voltage correct?
NO
YES
Replace A3CR1
EXIT
Check wiring from A3CR1 to T1 (refer to Fig. 6- 5)
Is wiring OK?
NO
Replace defective component
EXIT
YES
Replace Power Supply
EXIT

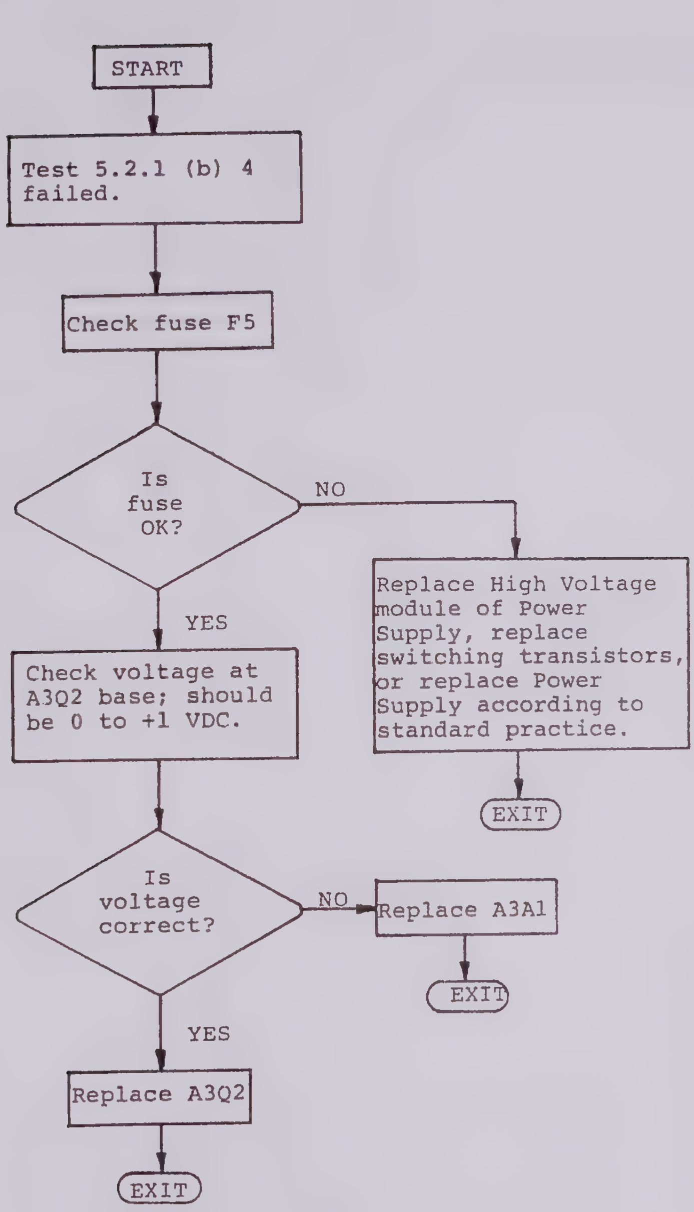
TROUBLESHOOTING FLOW DIAGRAM

SHEET 3


START
Test 5.2.1 (b)3 failed.
Check -5V fuse A3F2
Is fuse OK?
NO
Remove -5V OVP IC, A3Z3
Is fuse OK?
NO
19A
YES
Replace A3Z2
EXIT
YES
Check voltage at -5V fuse; should be -8 to -12 VDC
Is voltage correct?
NO
Check for -8 to -12 V RMS at AC terminals of A3CR2
Is voltage correct?
NO
YES
Replace A3CR2
EXIT
YES
Replace A3VR3
EXIT
Check wiring from A3CR2 to T1 (refer to Fig. 6- 5)
Is wiring OK?
NO
Replace defective component
EXIT
YES
Replace Power Supply
EXIT

TROUBLESHOOTING FLOW DIAGRAM

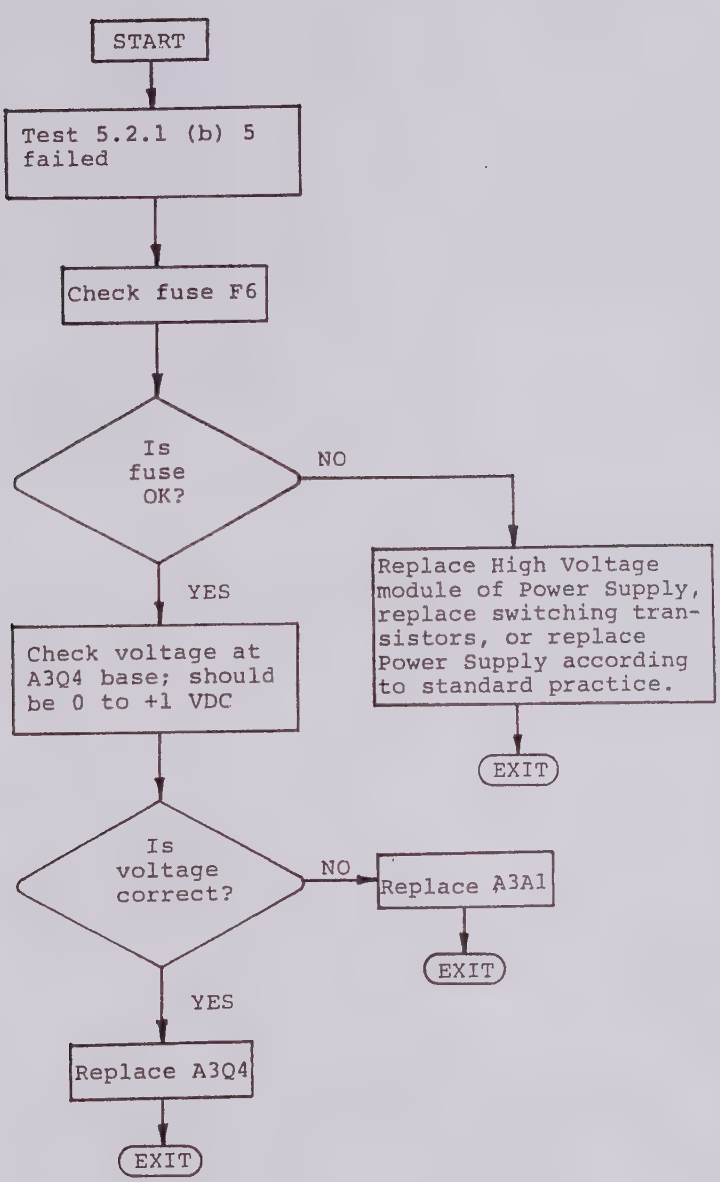
SHEET 4

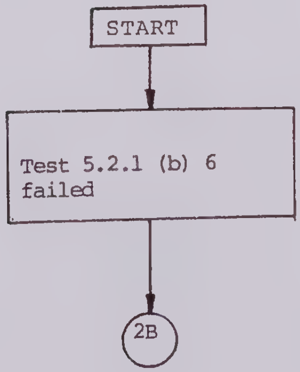

START
Test 5.2.1 (b) 4 failed.
Check fuse F5
Is fuse OK?
NO
Replace High Voltage module of Power Supply, replace switching transistors, or replace Power Supply according to standard practice.
EXIT
YES
Check voltage at A3Q2 base; should be 0 to +1 VDC.
Is voltage correct?
NO
Replace A3A1
EXIT
YES
Replace A3Q2
EXIT

EP250C

TROUBLESHOOTING FLOW DIAGRAM

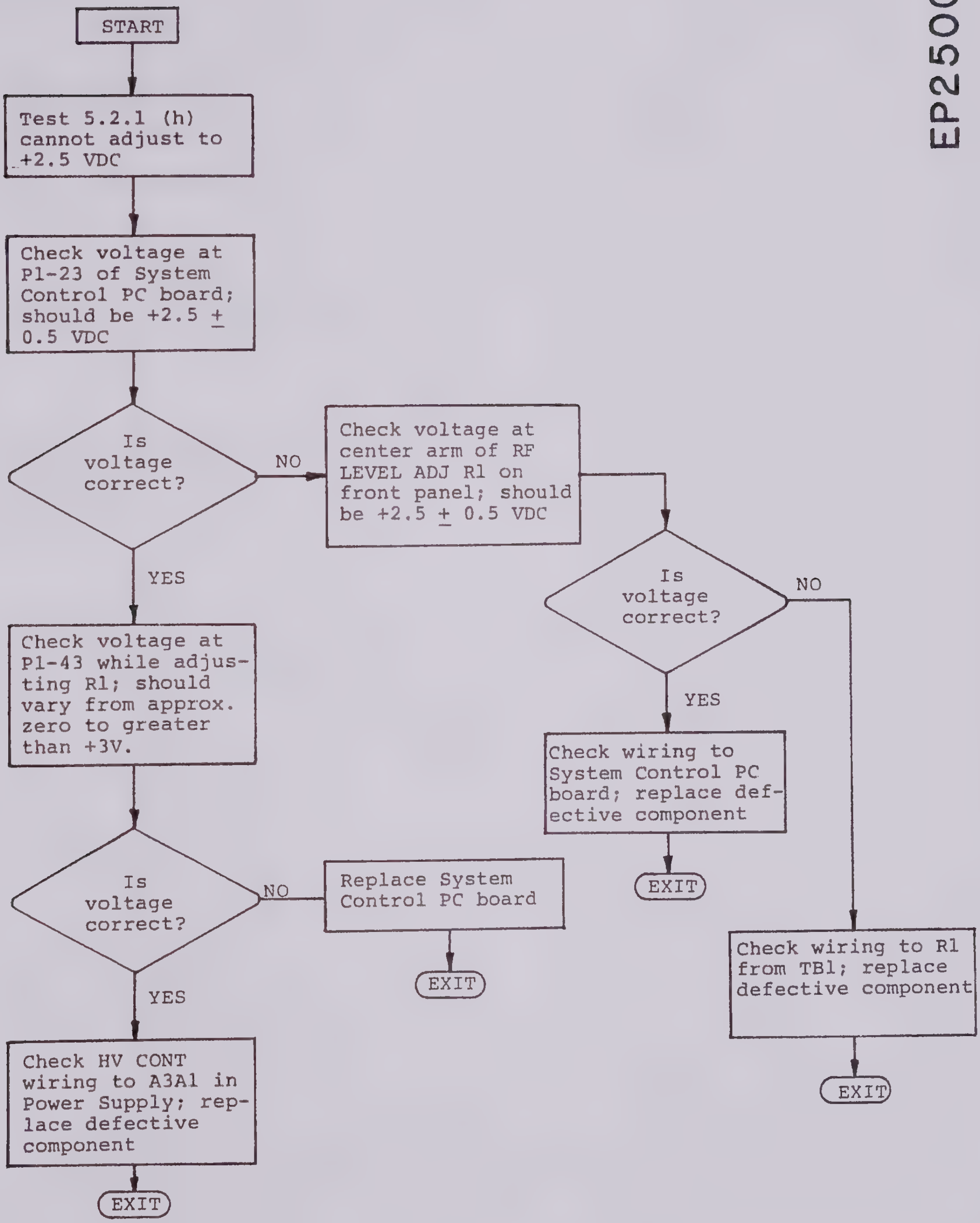
SHEET 5

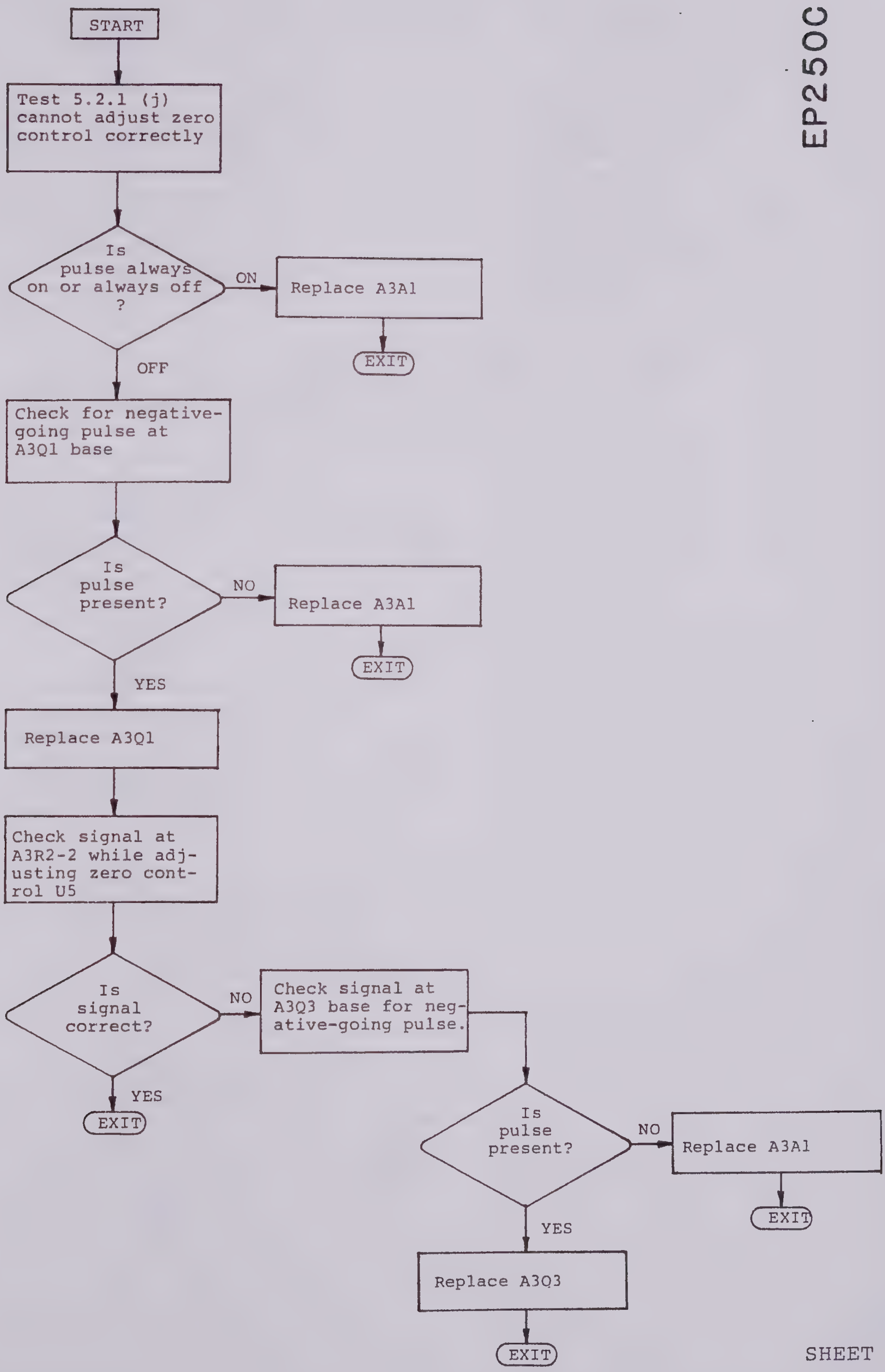

START
Test 5.2.1 (b) 5 failed
Check fuse F6
Is fuse OK?
NO
Replace High Voltage module of Power Supply, replace switching transistors, or replace Power Supply according to standard practice.
EXIT
YES
Check voltage at A3Q4 base; should be 0 to +1 VDC
Is voltage correct?
NO
Replace A3A1
EXIT
YES
Replace A3Q4
EXIT


START
Test 5.2.1 (b) 6 failed
2B

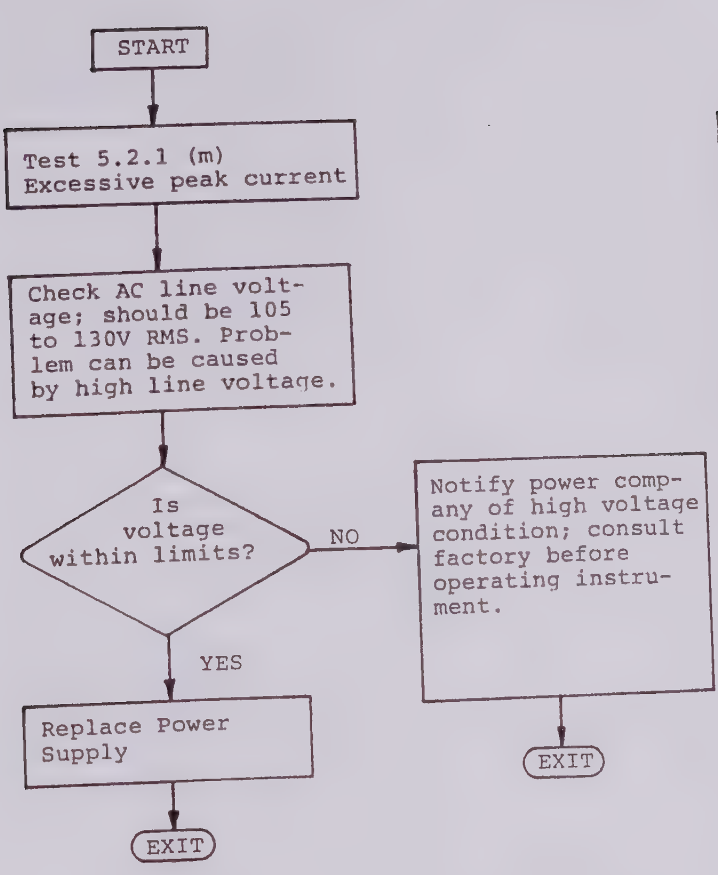
TROUBLESHOOTING FLOW DIAGRAM

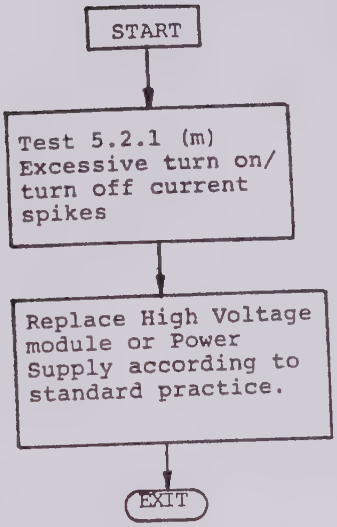
TROUBLESHOOTING FLOW DIAGRAM

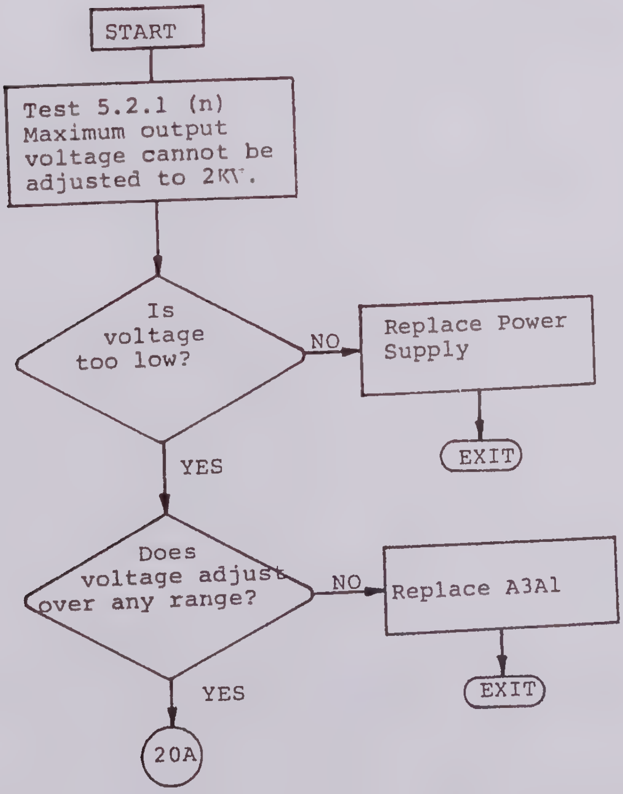

START
Test 5.2.1 (h) cannot adjust to +2.5 VDC
Check voltage at P1-23 of System Control PC board; should be +2.5 ± 0.5 VDC
Is voltage correct?
NO
Check voltage at center arm of RF LEVEL ADJ R1 on front panel; should be +2.5 ± 0.5 VDC
Is voltage correct?
NO
YES
Check wiring to System Control PC board; replace defective component
EXIT
Check wiring to R1 from TB1; replace defective component
EXIT
YES
Check voltage at P1-43 while adjusting R1; should vary from approx. zero to greater than +3V.
Is voltage correct?
NO
Replace System Control PC board
EXIT
YES
Check HV CONT wiring to A3A1 in Power Supply; replace defective component
EXIT


START
Test 5.2.1 (j) cannot adjust zero control correctly
Is pulse always on or always off ?
ON
Replace A3A1
EXIT
OFF
Check for negative-going pulse at A3Q1 base
Is pulse present?
NO
Replace A3A1
EXIT
YES
Replace A3Q1
Check signal at A3R2-2 while adjusting zero control U5
Is signal correct?
NO
Check signal at A3Q3 base for negative-going pulse.
YES
EXIT
Is pulse present?
NO
Replace A3A1
EXIT
YES
Replace A3Q3
EXIT

TROUBLESHOOTING FLOW DIAGRAM

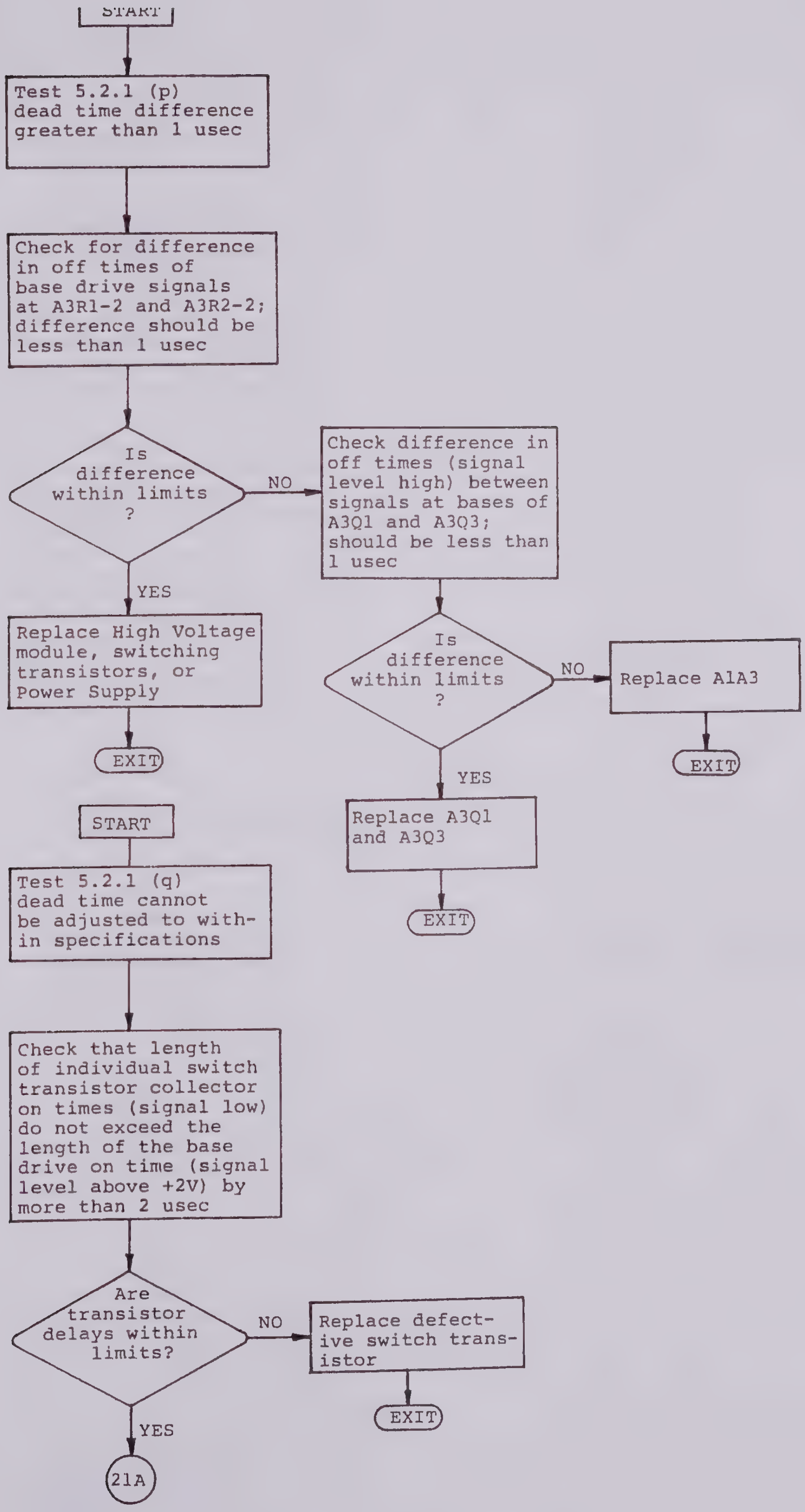

START
Test 5.2.1 (m)
Excessive peak current
Check AC line voltage; should be 105 to 130V RMS. Problem can be caused by high line voltage.
Is voltage within limits?
NO
Notify power company of high voltage condition; consult factory before operating instrument.
EXIT
YES
Replace Power Supply
EXIT


START
Test 5.2.1 (m)
Excessive turn on/ turn off current spikes
Replace High Voltage module or Power Supply according to standard practice.
EXIT


START
Test 5.2.1 (n)
Maximum output voltage cannot be adjusted to 2KV.
Is voltage too low?
NO
Replace Power Supply
EXIT
YES
Does voltage adjust over any range?
NO
Replace A3A1
EXIT
YES
20A

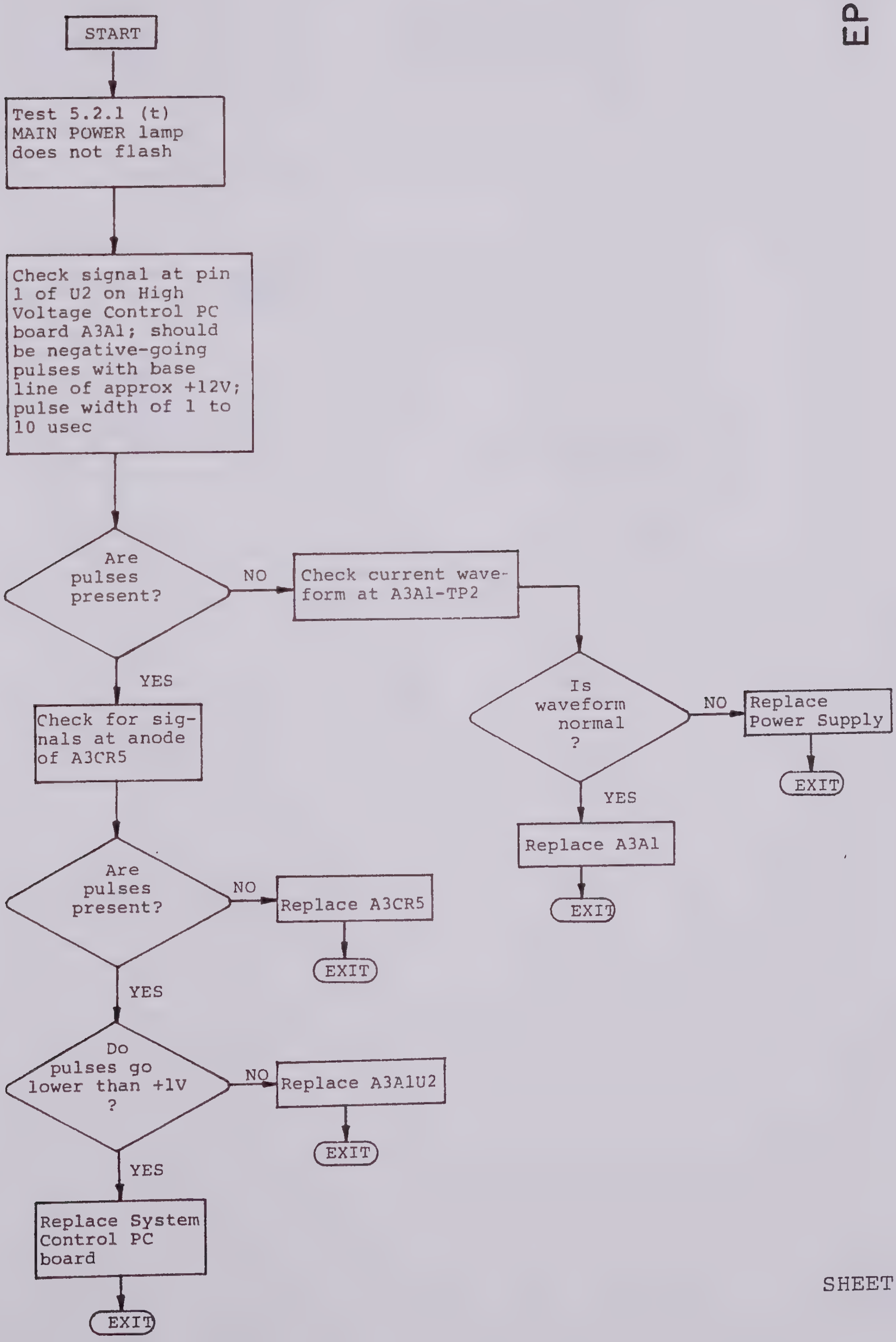
TROUBLESHOOTING FLOW DIAGRAM

EP250C


START
Test 5.2.1 (p) dead time difference greater than 1 usec
Check for difference in off times of base drive signals at A3R1-2 and A3R2-2; difference should be less than 1 usec
Is difference within limits ?
NO
Check difference in off times (signal level high) between signals at bases of A3Q1 and A3Q3; should be less than 1 usec
YES
Replace High Voltage module, switching transistors, or Power Supply
EXIT
Is difference within limits ?
NO
Replace A1A3
EXIT
YES
Replace A3Q1 and A3Q3
EXIT
START
Test 5.2.1 (q) dead time cannot be adjusted to within specifications
Check that length of individual switch transistor collector on times (signal low) do not exceed the length of the base drive on time (signal level above +2V) by more than 2 usec
Are transistor delays within limits?
NO
Replace defective switch transistor
EXIT
YES
21A

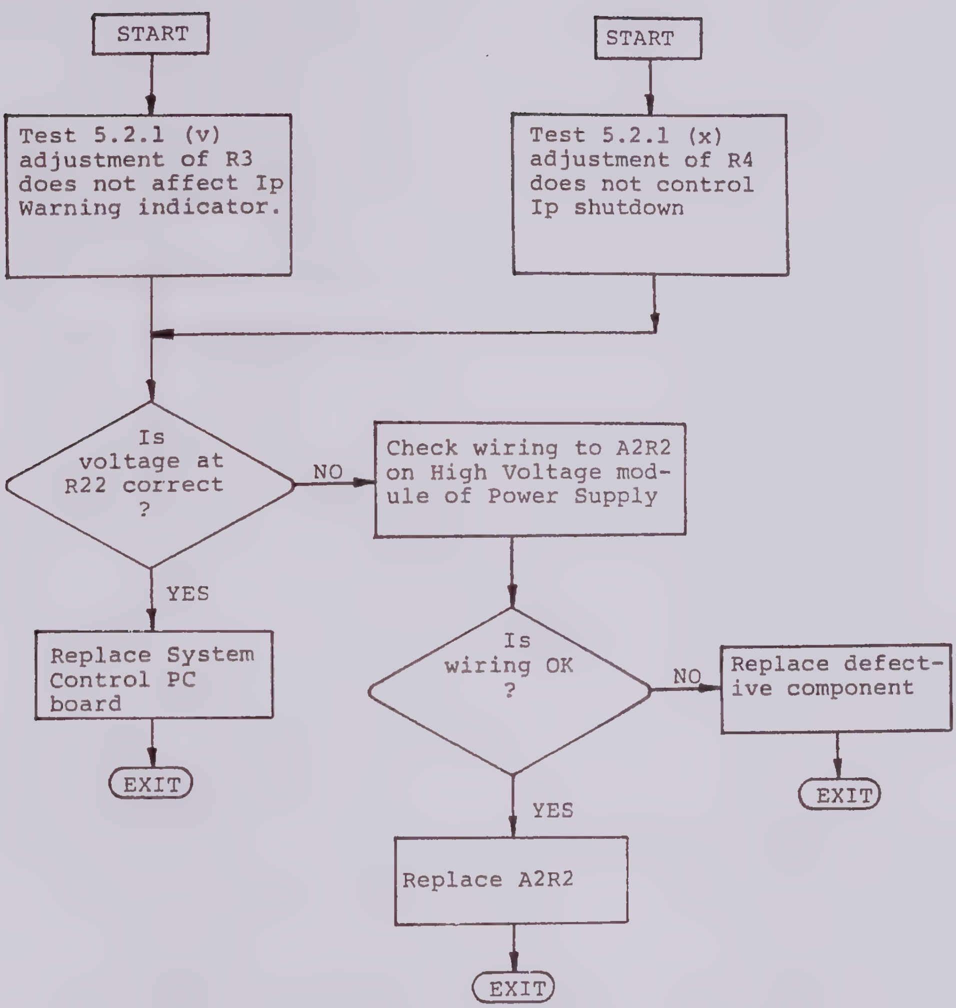
TROUBLESHOOTING FLOW DIAGRAM

SHEET 10

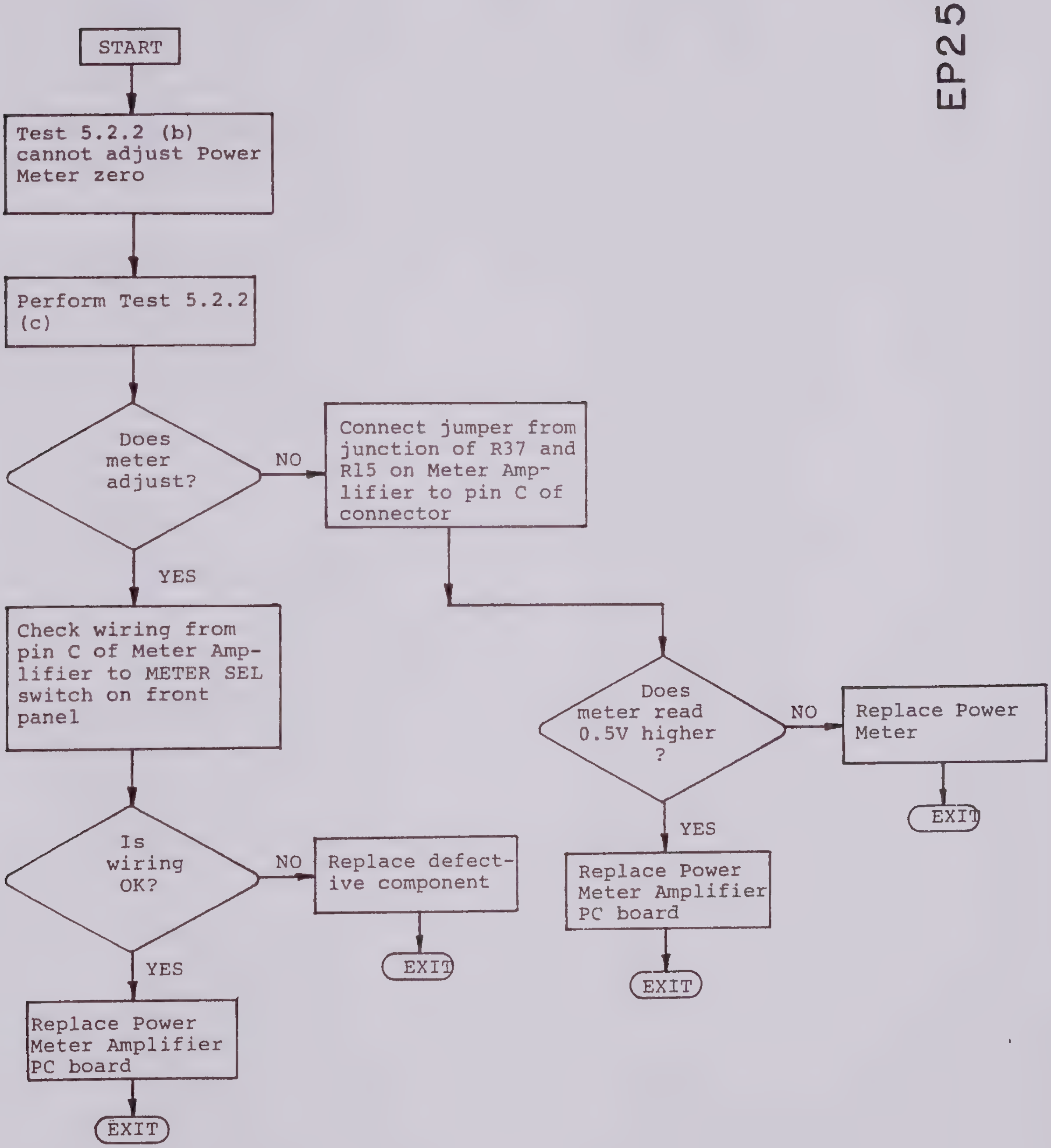

START
Test 5.2.1 (t) MAIN POWER lamp does not flash
Check signal at pin 1 of U2 on High Voltage Control PC board A3A1; should be negative-going pulses with base line of approx +12V; pulse width of 1 to 10 usec
Are pulses present?
NO
Check current waveform at A3A1-TP2
Is waveform normal ?
NO
Replace Power Supply
EXIT
YES
Replace A3A1
EXIT
YES
Check for signals at anode of A3CR5
Are pulses present?
NO
Replace A3CR5
EXIT
YES
Do pulses go lower than +1V ?
NO
Replace A3A1U2
EXIT
YES
Replace System Control PC board
EXIT

TROUBLESHOOTING FLOW DIAGRAM

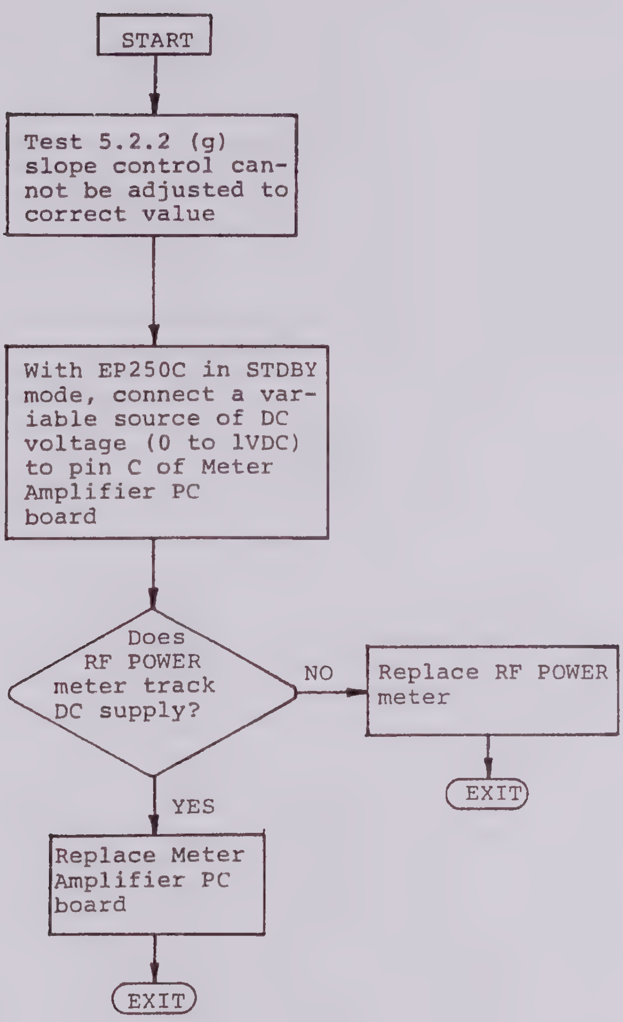
TROUBLESHOOTING FLOW DIAGRAM


START
Test 5.2.1 (v) adjustment of R3 does not affect Ip Warning indicator.
START
Test 5.2.1 (x) adjustment of R4 does not control Ip shutdown
Is voltage at R22 correct ?
NO
Check wiring to A2R2 on High Voltage module of Power Supply
YES
Replace System Control PC board
EXIT
Is wiring OK ?
NO
Replace defective component
EXIT
YES
Replace A2R2
EXIT

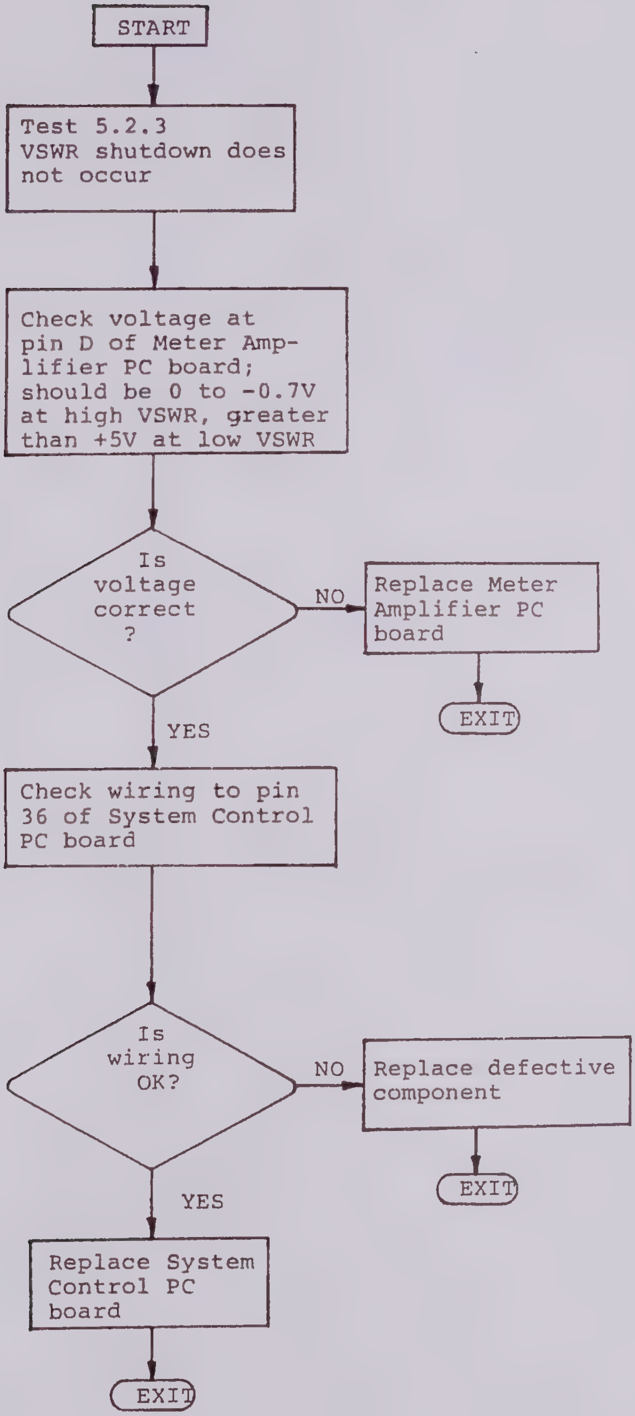
EP250C

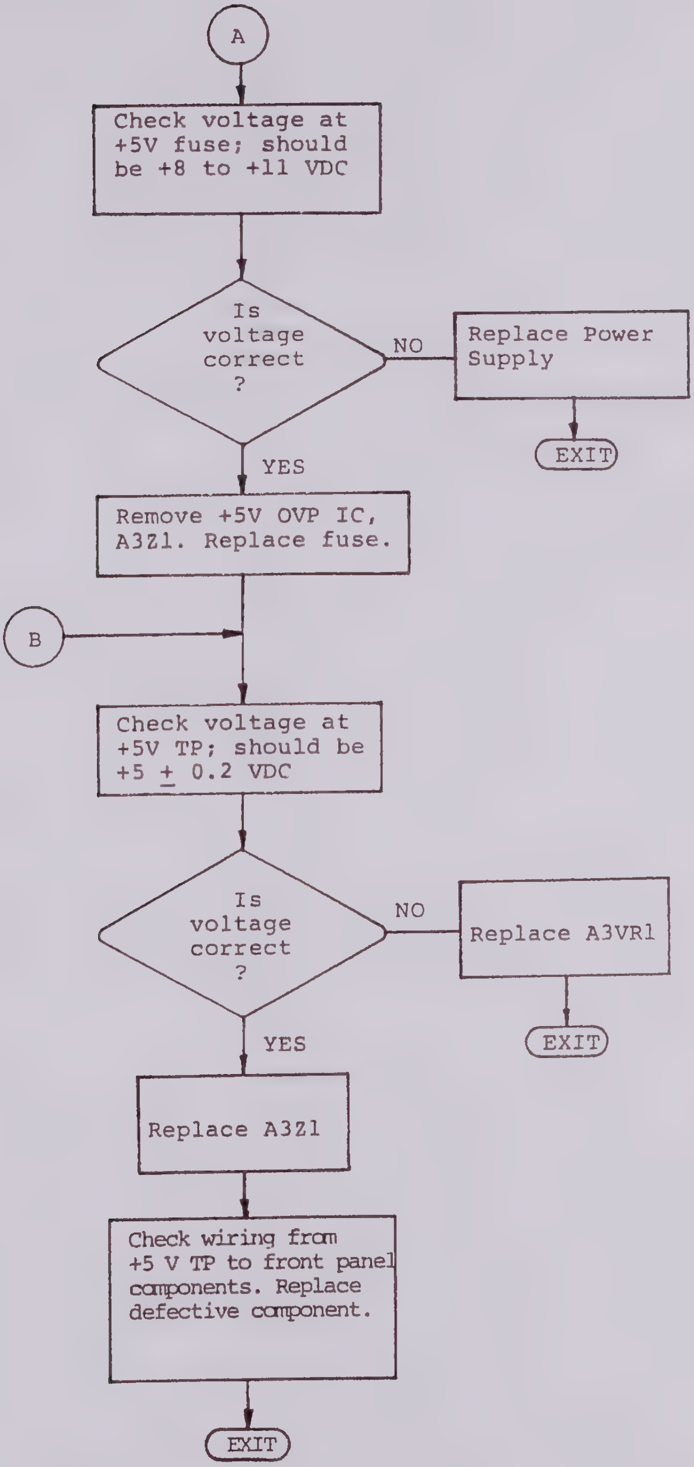

START
Test 5.2.2 (b) cannot adjust Power Meter zero
Perform Test 5.2.2 (c)
Does meter adjust?
NO
Connect jumper from junction of R37 and R15 on Meter Amplifier to pin C of connector
YES
Check wiring from pin C of Meter Amplifier to METER SEL switch on front panel
Does meter read 0.5V higher ?
NO
Replace Power Meter
EXIT
YES
Is wiring OK?
NO
Replace defective component
EXIT
Replace Power Meter Amplifier PC board
EXIT
YES
Replace Power Meter Amplifier PC board
EXIT

TROUBLESHOOTING FLOW DIAGRAM

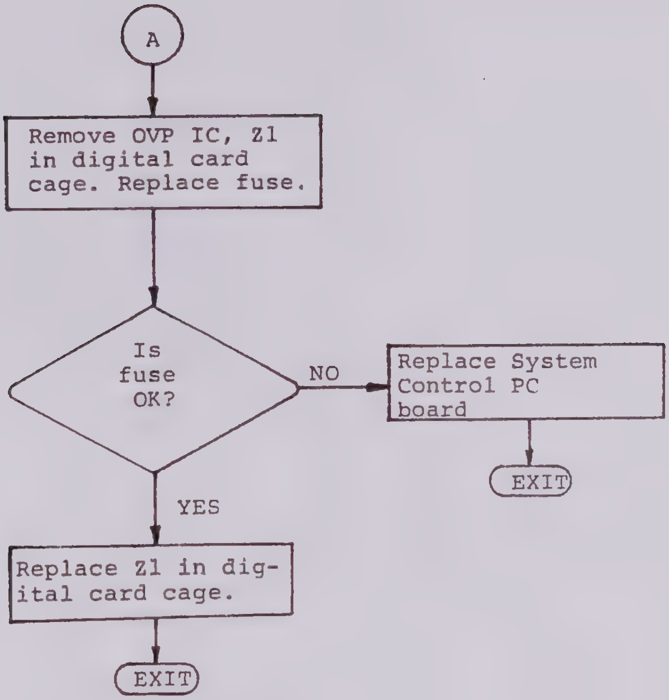

START
Test 5.2.2 (g) slope control cannot be adjusted to correct value
With EP250C in STDBY mode, connect a variable source of DC voltage (0 to 1VDC) to pin C of Meter Amplifier PC board
Does RF POWER meter track DC supply?
NO
Replace RF POWER meter
EXIT
YES
Replace Meter Amplifier PC board
EXIT

TROUBLESHOOTING FLOW DIAGRAM

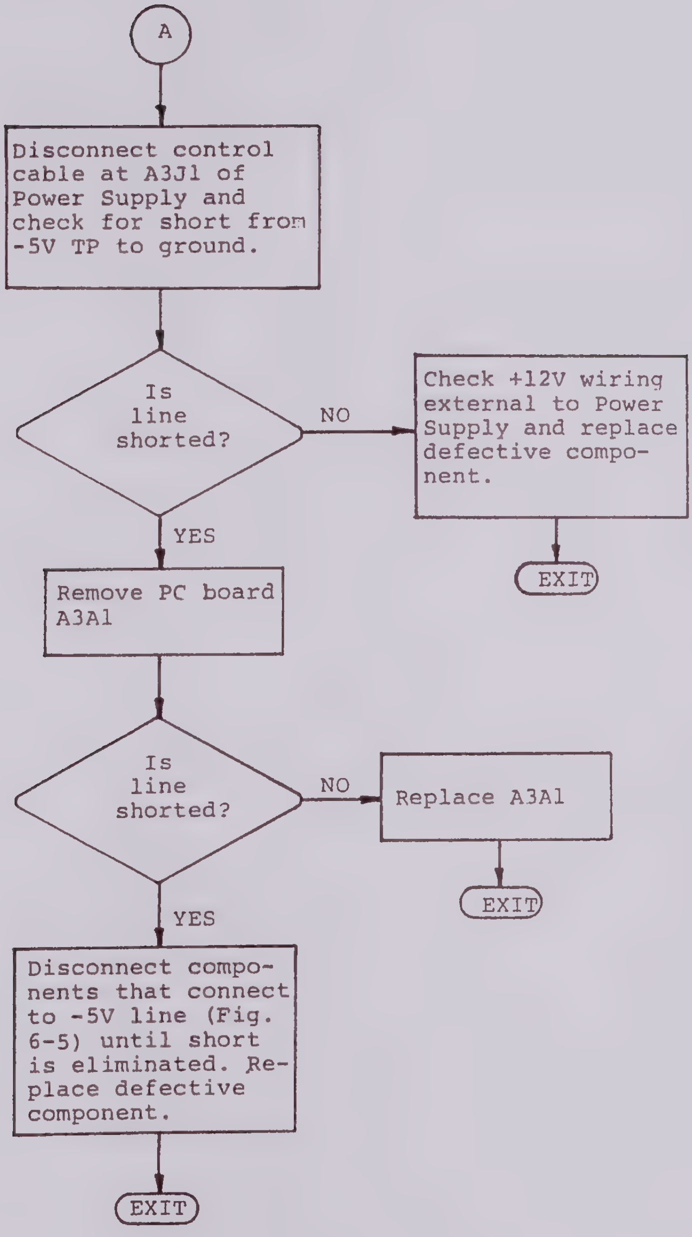

START
Test 5.2.3 VSWR shutdown does not occur
Check voltage at pin D of Meter Amplifier PC board; should be 0 to -0.7V at high VSWR, greater than +5V at low VSWR
Is voltage correct ?
NO
Replace Meter Amplifier PC board
EXIT
YES
Check wiring to pin 36 of System Control PC board
Is wiring OK?
NO
Replace defective component
EXIT
YES
Replace System Control PC board
EXIT


A
Check voltage at +5V fuse; should be +8 to +11 VDC
Is voltage correct ?
NO
Replace Power Supply
EXIT
YES
Remove +5V OVP IC, A3Z1. Replace fuse.
B
Check voltage at +5V TP; should be +5 ± 0.2 VDC
Is voltage correct ?
NO
Replace A3VR1
EXIT
YES
Replace A3Z1
Check wiring from +5 V TP to front panel components. Replace defective component.
EXIT

TROUBLESHOOTING FLOW DIAGRAM

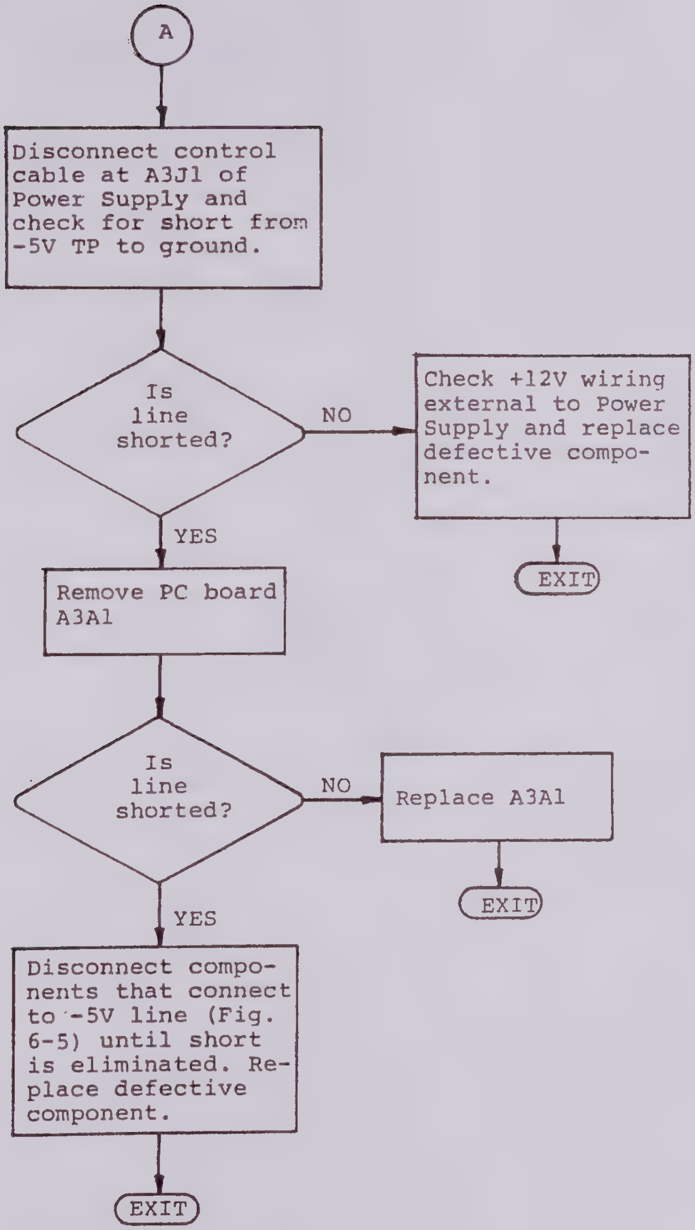

A
Remove OVP IC, Z1 in digital card cage. Replace fuse.
Is fuse OK?
NO
Replace System Control PC board
EXIT
YES
Replace Z1 in digital card cage.
EXIT

EP250C

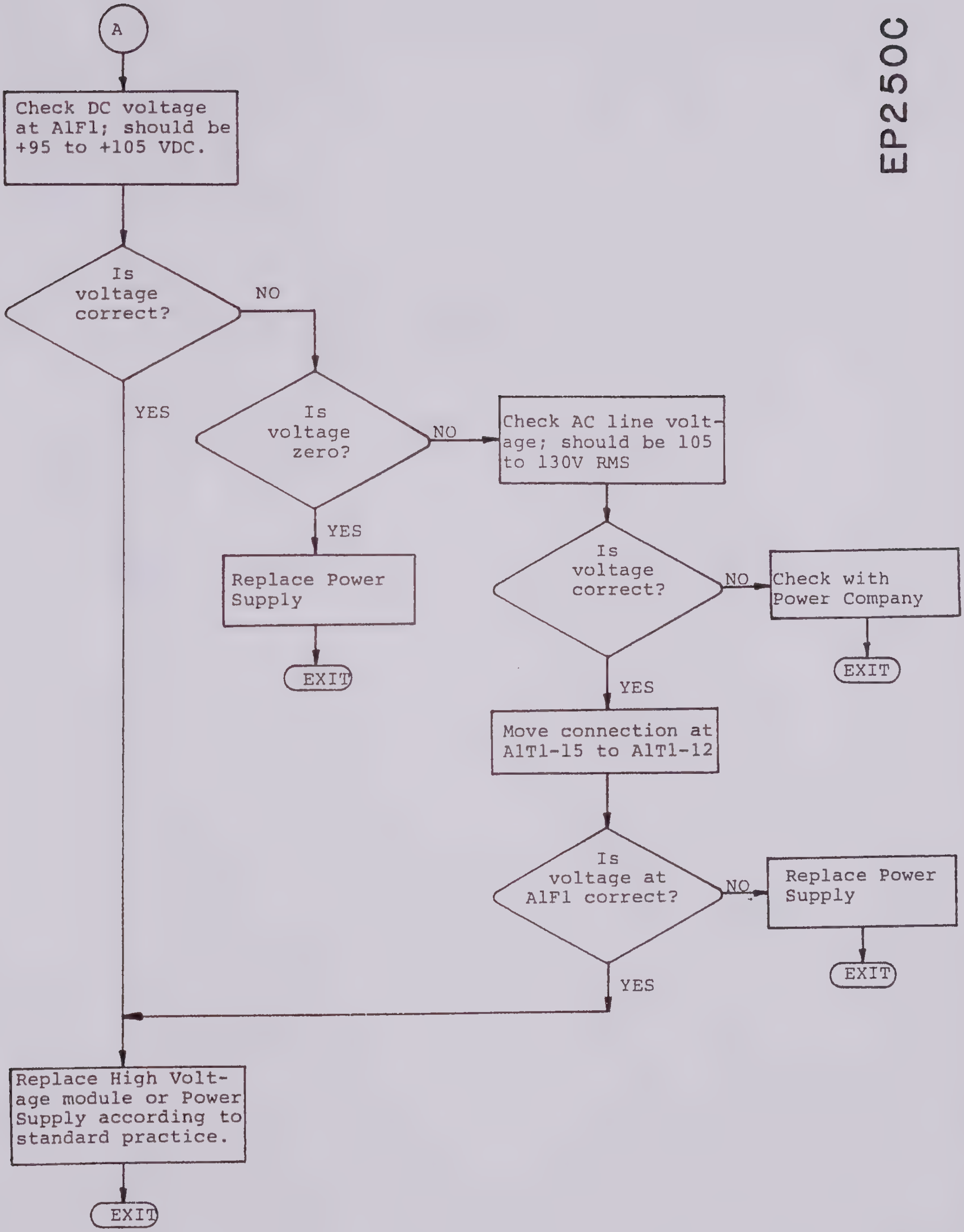

A
Disconnect control cable at A3J1 of Power Supply and check for short from -5V TP to ground.
Is line shorted?
NO
Check +12V wiring external to Power Supply and replace defective component.
EXIT
YES
Remove PC board A3A1
Is line shorted?
NO
Replace A3A1
EXIT
YES
Disconnect components that connect to -5V line (Fig. 6-5) until short is eliminated. Replace defective component.
EXIT

TROUBLESHOOTING FLOW DIAGRAM

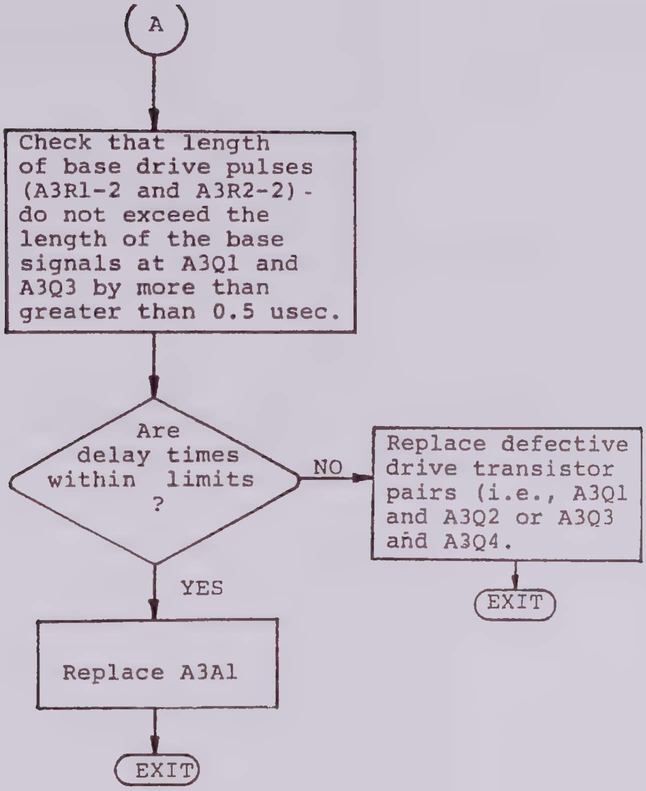
EP250C


A
Disconnect control cable at A3J1 of Power Supply and check for short from -5V TP to ground.
Is line shorted?
NO
Check +12V wiring external to Power Supply and replace defective component.
EXIT
YES
Remove PC board A3A1
Is line shorted?
NO
Replace A3A1
EXIT
YES
Disconnect components that connect to -5V line (Fig. 6-5) until short is eliminated. Replace defective component.
EXIT

TROUBLESHOOTING FLOW DIAGRAM


A
Check DC voltage at A1F1; should be +95 to +105 VDC.
Is voltage correct?
NO
YES
Is voltage zero?
NO
YES
Check AC line voltage; should be 105 to 130V RMS
Replace Power Supply
EXIT
Is voltage correct?
NO
Check with Power Company
EXIT
YES
Move connection at A1T1-15 to A1T1-12
Is voltage at A1F1 correct?
NO
Replace Power Supply
EXIT
YES
Replace High Voltage module or Power Supply according to standard practice.
EXIT

TROUBLESHOOTING FLOW DIAGRAM


A
Check that length of base drive pulses (A3R1-2 and A3R2-2) - do not exceed the length of the base signals at A3Q1 and A3Q3 by more than greater than 0.5 usec.
Are delay times within limits ?
NO
Replace defective drive transistor pairs (i.e., A3Q1 and A3Q2 or A3Q3 and A3Q4.
EXIT
YES
Replace A3A1
EXIT

SECTION VI

DRAWINGS

This section of the manual contains the wiring (interconnection) diagrams, schematic diagrams, and assembly drawings for the Model EP250C Power Source.

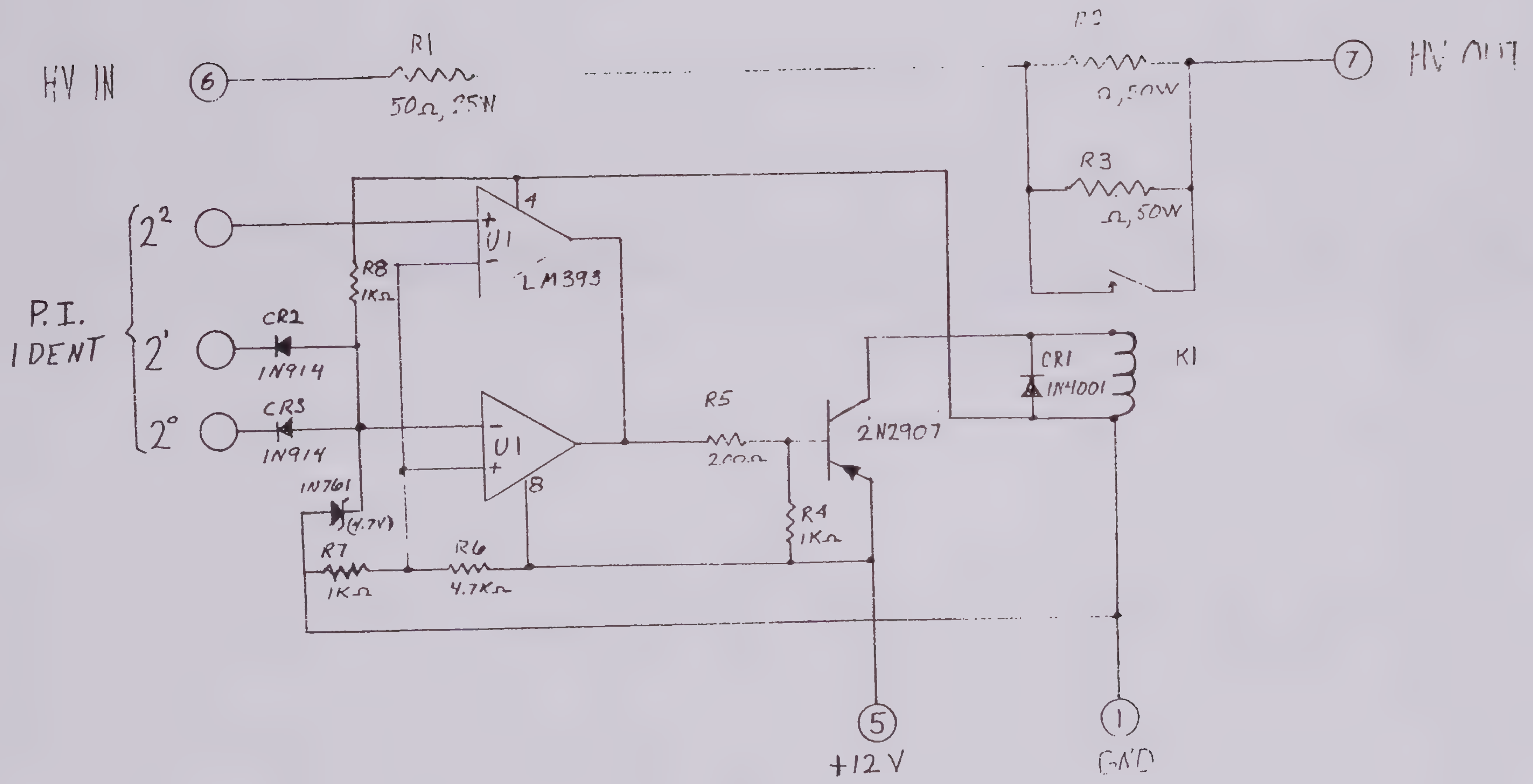

HV IN
⑥
R1
50Ω, 25W
R2
Ω, 50W
⑦
HV OUT
R3
Ω, 50W
P.I.
IDENT
2^2
2^1
2^0
CR2
1N914
CR3
1N914
R8
1KΩ
4
U1
LM393
U1
8
1N761
(4.7V)
R7
1KΩ
R6
4.7KΩ
R5
200Ω
R4
1KΩ
2N2907
CR1
1N4001
K1
⑤
+12V
①
GND

FIG. 6- . HV SWITCH ASSY
EP250C

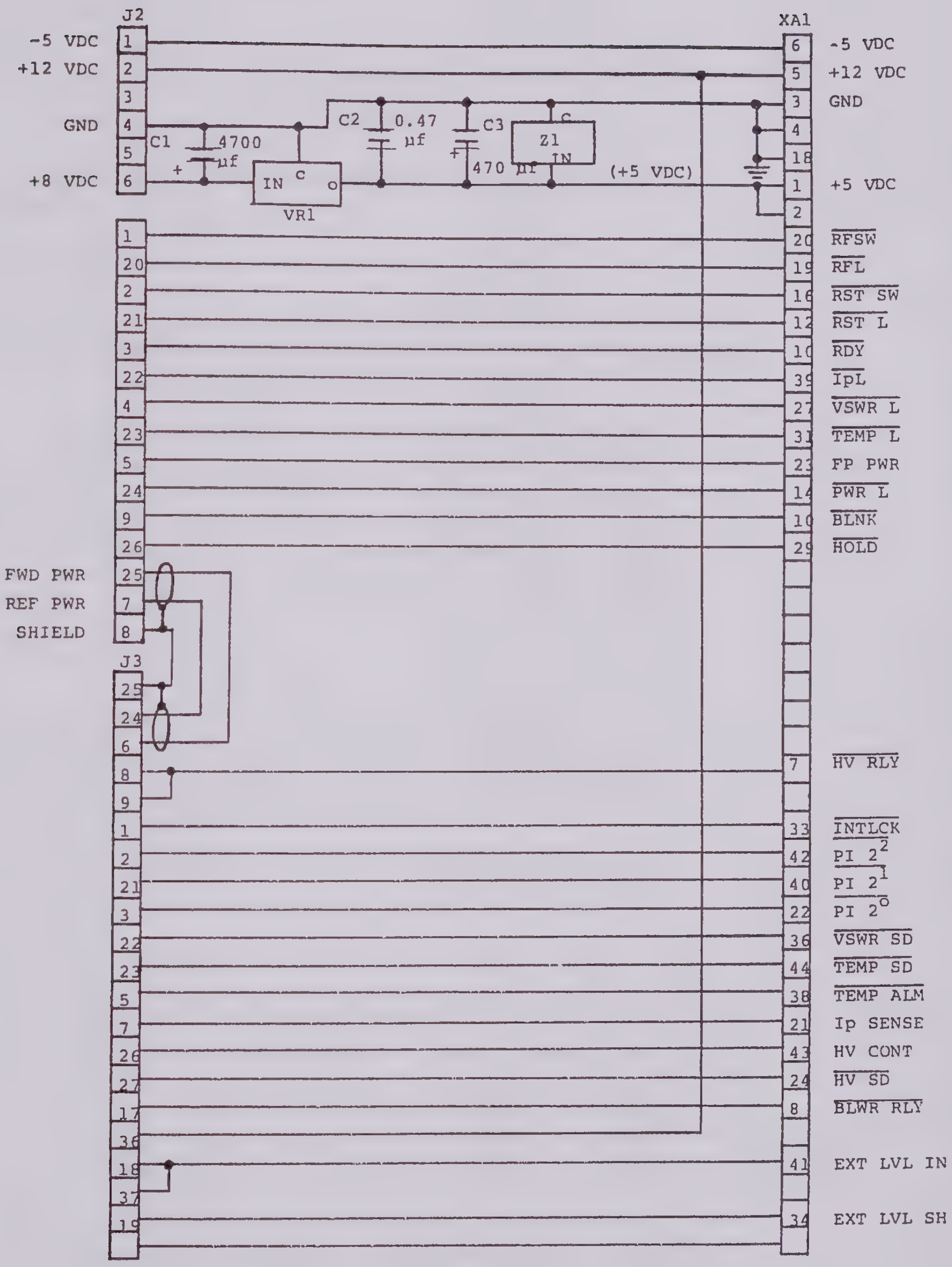

J2
XA1
-5 VDC
+12 VDC
GND
+8 VDC
C1
4700 µf
VR1
IN
C
O
C2
0.47 µf
C3
470 µf
Z1
IN
C
(+5 VDC)
-5 VDC
+12 VDC
GND
+5 VDC
RFSW
RFL
RST SW
RST L
RDY
IpL
VSWR L
TEMP L
FP PWR
PWR L
BLNK
HOLD
FWD PWR
REF PWR
SHIELD
J3
HV RLY
INTLCK
PI 2^2
PI 2^1
PI 2^0
VSWR SD
TEMP SD
TEMP ALM
Ip SENSE
HV CONT
HV SD
BLWR RLY
EXT LVL IN
EXT LVL SH

Figure 6-3. Schematic Diagram, Digital Card Cage
Model EP250C

APPENDIX ~~D~~A

~~D~~A.0 CAVITY OSCILLATOR ASSEMBLY, PLUG-IN
Model M80~~60~~20H

~~D~~A.1 General

The plug-in cavity oscillator assembly consists of a high-power oscillator stage, RF power detector, meter amplifier P.C. board assembly, and thermal sensors.

The plug-in assembly covers the frequency range of ~~700~~10 50 to ~~1200~~ MHz, with the operating frequency being controlled by the FREQUENCY ADJ control on the front panel. The RF output, available at the RF OUT connector, can be varied from less than 20 watts to greater than 225 watts throughout the frequency range. The maximum output power available varies with frequency and differs slightly from unit to unit.

Figure ~~D~~A-1 is a graph of the maximum output power vs. frequency for the average cavity. It should be noted that when the power level is set to maximum, the output ripple may exceed the level given in the Table of Specifications (Section I, Table 1-1).

A complete list of specifications for this plug-in is given in Table ~~D~~A-1.

~~D~~A.2 Installation

The plug-in assembly is installed in the EP250C Power Source main frame as described in the following steps.

a. Set the rear of the plug-in chassis on the two mounting brackets in the plug-in chamber and push the plug-in straight back.

b. Be sure that the rear of the plug-in front panel is flush against the front panel of the main frame.

c. Tighten the two captive screws at the bottom of the plug-in front panel finger-tight. The installation is complete.

Figure A-1. RF Output Vs. Frequency Curve

Table ~~D~~A-1. Model M80~~60~~20H Specifications

FREQUENCY

Range	~~700~~ 10 to ~~1200~~ 50 MHz
Stability	0.04%/hr. under constant conditions
Reset Accuracy	0.5%

POWER

Input	-2000 VDC max at 0.5 Amperes max.
Output	225 watts min with LEVEL set to maximum
Stability	0.1 dB/hr.
Output Range	10 dB minimum

LOAD REQUIREMENTS

Impedance	50 ohms
VSWR	1.7 to 1 maximum at full rated power

WARNING

NEVER REMOVE A PLUG-IN ASSEMBLY
WHILE THE EP250C POWER SOURCE IS
IN THE RF ON MODE OF OPERATION.

d. The plug-in is removed by performing the preceding steps in the reverse order.

No electrical alignment or adjustment is necessary if the plug-in assembly is always used with the same main frame.

Note

If a plug-in is to be used in two or more models of main frames, power meter zero adjustments may be necessary to insure that the RF POWER meter reads within specifications. See Section V of this manual.

~~D~~A.3 Operation

Operating instructions for the M8045H Plug-In assembly are given in Section III of this manual because it is the most commonly used plug-in. When the Model M 2020 H plug-in is installed, the same procedures apply except that the references to frequency must take into account the operating range of the Model M 8020 H oscillator.

~~D~~A.4 Theory of Operation

The following paragraphs, in conjunction with paragraphs 4.1 and 4.2 of this manual, form a complete description of the operation of the Model EP250C Power Source with a Model 20 M80~~60~~H plug-in oscillator assembly installed. Figure ~~D~~A-2 is a schematic diagram of the plug-in assembly. All references to the plug-in assembly in Section IV of this manual apply with the exception of frequency.

~~D~~A.4.1 Cavity Oscillator

The plug-in assembly uses a triode vacuum tube as the source of RF signals. The plate of the tube is grounded

Figure A-2. Schematic Diagram - Model M8020H
Plug-In Cavity Oscillator Assembly

through the cavity body. The tube is powered by a negative voltage from the High-Voltage Power Supply (HVPS) which is connected via the filament transformer on the main frame of the instrument. The negative DC voltage and the 6.3 VAC filament voltage are connected via common leads to the tube cathode/filament connections through the hollow cavity body. The oscillator is self-biased with R1 providing the grid-to-cathode connection. The coaxial grid anode and cathode cavities form tuned circuits at a frequency determined by the physical length of cavities. This length is adjusted by the FREQUENCY ADJ control which varies the electrical length of the cavity and thereby the frequency of oscillation.

Positive feedback, required for oscillation, is accomplished by coupling a portion of the output signal back into the grid cavity. RF energy is coupled from the cavity to the output cable with a probe which acts as an adjustable capacitance. Varying the depth of probe insertion with the OUTPUT COUPLING control varies the capacitance and therefore the portion of the signal applied to the output. Excessive coupling reduces the positive feedback and efficiency of the oscillator, thereby reducing the output power and, at the same time, increasing plate current. Excessive coupling is to be avoided during operation.

A ~~B~~.4.2 Thermal Sensors

Thermal sensors S1 and S2 are mounted on the cavity body to detect overtemperature conditions. S1 closes at a temperature of 175 degrees F and activates the TEMP warning circuit on the System Control P.C. board. S2 operates at a temperature of 185 degrees F and activates the TEMP shutdown circuit. The two switches have a high degree of hysteresis and once closed, will not open until the cavity body temperature drops below approximately 100 degrees F.

A ~~B~~.4.3 Meter Amplifier and High VSWR Detector Circuits

A complete description of these circuits is given in paragraphs 4.1.8 and 4.2.4 of this manual.

A~~B~~.5 Maintenance

A~~B~~.5.1 Test and Alignment

Test and alignment of the plug-in assembly can be performed only when it is installed in an EP250C main frame. See Section V, paragraphs 5.1 and 5.2, for Test and Alignment procedures.

A~~B~~.5.2 Subassembly Replacement

The Meter Amplifier P.C. board and the Power Sensor Z1 are the two replaceable subassemblies.

A~~B~~.5.2.1 Meter Amplifier P.C. Board Replacement

The Meter Amplifier P.C. board is replaced as described in the following steps.

a. Disconnect the cable connectors from P1 of the P.C. board assembly.

b. Remove the four nuts and washers holding the board assembly to the wall of the chassis.

c. To install the replacement board, follow the preceding steps in the reverse order.

A~~B~~.5.2.2 Power Sensor Replacement

Power Sensor Replacement is described in the following steps.

a. With the plug-in assembly inverted, disconnect the RF cable from the INPUT connector of the sensor.

b. Remove the nut holding the RF OUT connector on the front panel of the plug-in assembly.

c. Mark the leads for future installation, then unsolder the leads from the REF, FOR, and GND terminals of the sensor.

d. Remove the mounting screws holding the sensor to the chassis.

e. Remove the sensor.

f. Install the replacement sensor by following the preceding steps in the reverse order.

~~D~~A.5.3 Component Replacement

The only field-replaceable components in the unit (other than wires and cables) are the two temperature sensors and the oscillator tube.

~~D~~A.5.3.1 Temperature Sensor Replacement

Temperature sensor replacement is accomplished by unsoldering the leads from the terminals of the sensor to be replaced and unscrewing the sensor from the cavity body.

When installing the replacement sensor, either terminal may be connected to the output or ground lead.

~~D~~A.5.3.2 Oscillator Tube Replacement

Replace the oscillator tube as described in the following steps.

a. Facing the rear of the plug-in, remove the three screws holding the tube cover to the body of the cavity.

b. Remove the tube cover from the tube.

c. Remove the tube from the cavity body by pulling it straight out.

d. Install the new tube by following the preceding steps in the reverse order.

Note

It is not necessary to retune or readjust the cavity when the tube is replaced.

APPENDIX ~~D~~ B

~~D~~ B.0 CAVITY OSCILLATOR ASSEMBLY, PLUG-IN
Model M80~~60~~ 30 H

~~D~~ B.1 General

The plug-in cavity oscillator assembly consists of a high-power oscillator stage, RF power detector, meter amplifier P.C. board assembly, and thermal sensors.

The plug-in assembly covers the frequency range of ~~700~~ 50 to ~~1200~~ 200 MHz, with the operating frequency being controlled by the FREQUENCY ADJ control on the front panel. The RF output, available at the RF OUT connector, can be varied from less than 20 watts to greater than 225 watts throughout the frequency range. The maximum output power available varies with frequency and differs slightly from unit to unit.

Figure ~~D~~ B-1 is a graph of the maximum output power vs. frequency for the average cavity. It should be noted that when the power level is set to maximum, the output ripple may exceed the level given in the Table of Specifications (Section I, Table 1-1).

A complete list of specifications for this plug-in is given in Table ~~D~~ B-1.

~~D~~ B.2 Installation

The plug-in assembly is installed in the EP250C Power Source main frame as described in the following steps.

a. Set the rear of the plug-in chassis on the two mounting brackets in the plug-in chamber and push the plug-in straight back.

b. Be sure that the rear of the plug-in front panel is flush against the front panel of the main frame.

c. Tighten the two captive screws at the bottom of the plug-in front panel finger-tight. The installation is complete.

Figure B-1. RF Output Vs. Frequency Curve

Table ~~D~~B-1. Model M80~~60~~30H Specifications

FREQUENCY	
Range	~~720~~ 50 to ~~1200~~ 200 MHz
Stability	0.04%/hr. under constant conditions
Reset Accuracy	0.5%
POWER	
Input	-2000 VDC max at 0.5 Amperes max.
Output	225 watts min with LEVEL set to maximum
Stability	0.1 dB/hr.
Output Range	10 dB minimum
LOAD REQUIREMENTS	
Impedance	50 ohms
VSWR	1.7 to 1 maximum at full rated power

WARNING

NEVER REMOVE A PLUG-IN ASSEMBLY WHILE THE EP250C POWER SOURCE IS IN THE RF ON MODE OF OPERATION.

d. The plug-in is removed by performing the preceding steps in the reverse order.

No electrical alignment or adjustment is necessary if the plug-in assembly is always used with the same main frame.

Note

If a plug-in is to be used in two or more models of main frames, power meter zero adjustments may be necessary to insure that the RF POWER meter reads within specifications. See Section V of this manual.

E ~~D~~.3 Operation

Operating instructions for the M8045H Plug-In assembly are given in Section III of this manual because it is the most commonly used plug-in. When the Model M 8030 H plug-in is installed, the same procedures apply except that the references to frequency must take into account the operating range of the Model M 8030 H oscillator.

D.4 Theory of Operation

The following paragraphs, in conjunction with paragraphs 4.1 and 4.2 of this manual, form a complete description of the operation of the Model EP250C Power Source with
3c a Model M8060H plug-in oscillator assembly installed. Figure D-2 is a schematic diagram of the plug-in assembly. All references to the plug-in assembly in Section IV of this manual apply with the exception of frequency.

B ~~D~~.4.1 Cavity Oscillator

The plug-in assembly uses a triode vacuum tube as the source of RF signals. The plate of the tube is grounded

Figure B-2. Schematic Diagram - Model M8030H
Plug-In Cavity Oscillator Assembly

through the cavity body. The tube is powered by a negative voltage from the High-Voltage Power Supply (HVPS) which is connected via the filament transformer on the main frame of the instrument. The negative DC voltage and the 6.3 VAC filament voltage are connected via common leads to the tube cathode/filament connections through the hollow cavity body. The oscillator is self-biased with R1 providing the grid-to-cathode connection. The coaxial grid anode and cathode cavities form tuned circuits at a frequency determined by the physical length of cavities. This length is adjusted by the FREQUENCY ADJ control which varies the electrical length of the cavity and thereby the frequency of oscillation.

Positive feedback, required for oscillation, is accomplished by coupling a portion of the output signal back into the grid cavity. RF energy is coupled from the cavity to the output cable with a probe which acts as an adjustable capacitance. Varying the depth of probe insertion with the OUTPUT COUPLING control varies the capacitance and therefore the portion of the signal applied to the output. Excessive coupling reduces the positive feedback and efficiency of the oscillator, thereby reducing the output power and, at the same time, increasing plate current. Excessive coupling is to be avoided during operation.

B ~~6~~.4.2 Thermal Sensors

Thermal sensors S1 and S2 are mounted on the cavity body to detect overtemperature conditions. S1 closes at a temperature of 175 degrees F and activates the TEMP warning circuit on the System Control P.C. board. S2 operates at a temperature of 185 degrees F and activates the TEMP shutdown circuit. The two switches have a high degree of hysteresis and once closed, will not open until the cavity body temperature drops below approximately 100 degrees F.

B ~~6~~.4.3 Meter Amplifier and High VSWR Detector Circuits

A complete description of these circuits is given in paragraphs 4.1.8 and 4.2.4 of this manual.

B ~~D~~.5 Maintenance

B ~~D~~.5.1 Test and Alignment

Test and alignment of the plug-in assembly can be performed only when it is installed in an EP250C main frame. See Section V, paragraphs 5.1 and 5.2, for Test and Alignment procedures.

B ~~D~~.5.2 Subassembly Replacement

The Meter Amplifier P.C. board and the Power Sensor Z1 are the two replaceable subassemblies.

B ~~D~~.5.2.1 Meter Amplifier P.C. Board Replacement

The Meter Amplifier P.C. board is replaced as described in the following steps.

a. Disconnect the cable connectors from P1 of the P.C. board assembly.

b. Remove the four nuts and washers holding the board assembly to the wall of the chassis.

c. To install the replacement board, follow the preceding steps in the reverse order.

B ~~D~~.5.2.2 Power Sensor Replacement

Power Sensor Replacement is described in the following steps.

a. With the plug-in assembly inverted, disconnect the RF cable from the INPUT connector of the sensor.

b. Remove the nut holding the RF OUT connector on the front panel of the plug-in assembly.

c. Mark the leads for future installation, then unsolder the leads from the REF, FOR, and GND terminals of the sensor.

d. Remove the mounting screws holding the sensor to the chassis.

e. Remove the sensor.

f. Install the replacement sensor by following the preceding steps in the reverse order.

B ~~D~~.5.3 Component Replacement

The only field-replaceable components in the unit (other than wires and cables) are the two temperature sensors and the oscillator tube.

B ~~D~~.5.3.1 Temperature Sensor Replacement

Temperature sensor replacement is accomplished by unsoldering the leads from the terminals of the sensor to be replaced and unscrewing the sensor from the cavity body.

When installing the replacement sensor, either terminal may be connected to the output or ground lead.

B ~~D~~.5.3.2 Oscillator Tube Replacement

Replace the oscillator tube as described in the following steps.

a. Facing the rear of the plug-in, remove the three screws holding the tube cover to the body of the cavity.

b. Remove the tube cover from the tube.

c. Remove the tube from the cavity body by pulling it straight out.

d. Install the new tube by following the preceding steps in the reverse order.

Note

It is not necessary to retune or readjust the cavity when the tube is replaced.

APPENDIX ~~D~~ C

C ~~D~~.0 CAVITY OSCILLATOR ASSEMBLY, PLUG-IN Model M80~~60~~H
45

C ~~D~~.1 General

The plug-in cavity oscillator assembly consists of a high-power oscillator stage, RF power detector, meter amplifier P.C. board assembly, and thermal sensors.

The plug-in assembly covers the frequency range of ~~700~~ 2cc
700 to ~~1~~200 MHz, with the operating frequency being controlled by the FREQUENCY ADJ control on the front panel. The RF output, available at the RF OUT connector, can be varied from less than 20 watts to greater than 225 watts throughout the frequency range. The maximum output power available varies with frequency and differs slightly from unit to unit.

Figure ~~D~~ C-1 is a graph of the maximum output power vs. frequency for the average cavity. It should be noted that when the power level is set to maximum, the output ripple may exceed the level given in the Table of Specifications (Section I, Table 1-1).

A complete list of specifications for this plug-in is given in Table ~~D~~ C-1.

C ~~D~~.2 Installation

The plug-in assembly is installed in the EP250C Power Source main frame as described in the following steps.

a. Set the rear of the plug-in chassis on the two mounting brackets in the plug-in chamber and push the plug-in straight back.

b. Be sure that the rear of the plug-in front panel is flush against the front panel of the main frame.

c. Tighten the two captive screws at the bottom of the plug-in front panel finger-tight. The installation is complete.

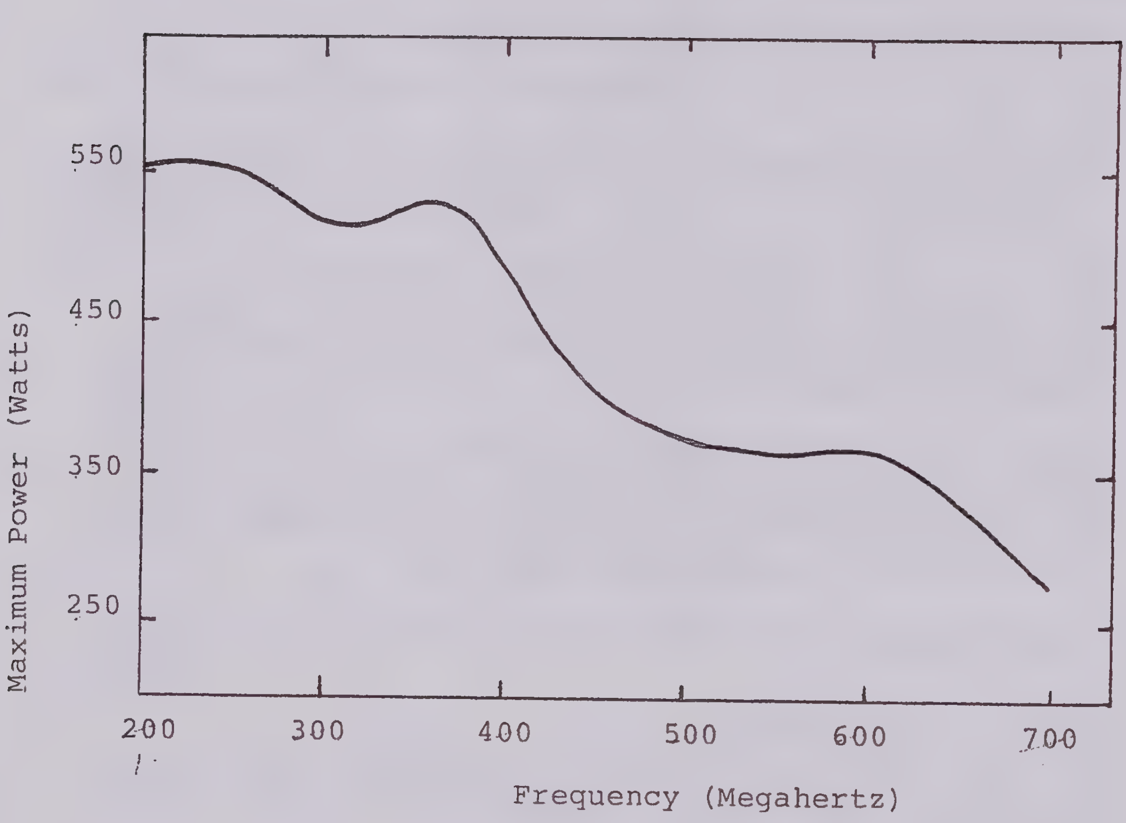


Figure ~~A~~C-1. RF Output vs Frequency
For ~~Average~~ Cavity Model
MBc45H

Table ~~D~~ C-1. Model M80~~65~~ 45H Specifications

FREQUENCY

Range	~~700~~ 200 to ~~1200~~ 700 MHz
Stability	0.04%/hr. under constant conditions
Reset Accuracy	0.5%

POWER

Input	-2000 VDC max at 0.5 Amperes max.
Output	225 watts min with LEVEL set to maximum
Stability	0.1 dB/hr.
Output Range	10 dB minimum

LOAD REQUIREMENTS

Impedance	50 ohms
VSWR	1.7 to 1 maximum at full rated power

WARNING

NEVER REMOVE A PLUG-IN ASSEMBLY WHILE THE EP250C POWER SOURCE IS IN THE RF ON MODE OF OPERATION.

d. The plug-in is removed by performing the preceding steps in the reverse order.

No electrical alignment or adjustment is necessary if the plug-in assembly is always used with the same main frame.

Note

If a plug-in is to be used in two or more models of main frames, power meter zero adjustments may be necessary to insure that the RF POWER meter reads within specifications. See Section V of this manual.

C ~~D~~.3 Operation

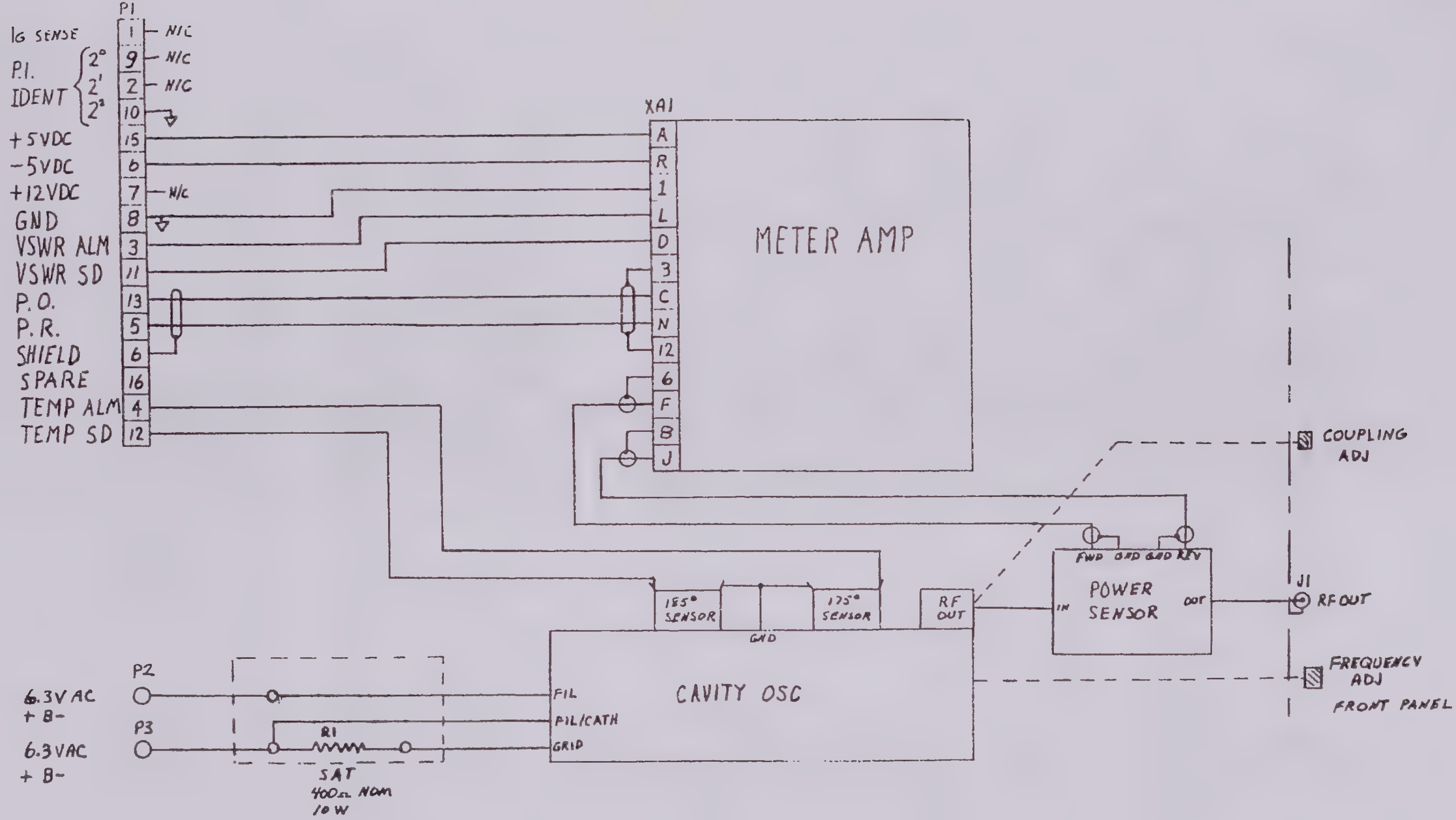
Operating instructions for the M8045H plug-in assembly are given in Section III of this manual. ~~When the Model M8060H plug-in is installed, the same procedures apply except that references to frequency must take into account the operating range of the Model M8060H oscillator~~.

C ~~D~~.4 Theory of Operation

The following paragraphs, in conjunction with paragraphs 4.1 and 4.2 of this manual, form a complete description of the operation of the Model EP250C Power Source with
45 a Model M80~~6~~0H plug-in oscillator assembly installed. Figure C ~~D~~-2 is a schematic diagram of the plug-in assembly. All references to the plug-in assembly in Section IV of this manual apply with the exception of frequency.

C ~~D~~.4.1 Cavity Oscillator

The plug-in assembly uses a triode vacuum tube as the source of RF signals. The plate of the tube is grounded



P1
1G SENSE
P.I. IDENT
2°
2¹
2²
+5VDC
−5VDC
+12VDC
GND
VSWR ALM
VSWR SD
P.O.
P.R.
SHIELD
SPARE
TEMP ALM
TEMP SD
1
9
2
10
15
6
7
8
3
11
13
5
6
16
4
12
N/C
N/C
N/C
N/C
XA1
A
R
1
L
D
3
C
N
12
6
F
B
J
METER AMP
155° SENSOR
GND
175° SENSOR
RF OUT
CAVITY OSC
FIL
FIL/CATH
GRID
FWD
GND
GND
REV
IN
POWER SENSOR
OUT
J1
RF OUT
COUPLING ADJ
FREQUENCY ADJ
FRONT PANEL
P2
6.3VAC
+ B−
P3
6.3VAC
+ B−
R1
SAT
400Ω NOM
10 W

Figure C-2. Schematic Diagram - Model M8045H Plug-In Cavity Oscillator Assembly

through the cavity body. The tube is powered by a negative voltage from the High-Voltage Power Supply (HVPS) which is connected via the filament transformer on the main frame of the instrument. The negative DC voltage and the 6.3 VAC filament voltage are connected via common leads to the tube cathode/filament connections through the hollow cavity body. The oscillator is self-biased with R1 providing the grid-to-cathode connection. The coaxial grid anode and cathode cavities form tuned circuits at a frequency determined by the physical length of cavities. This length is adjusted by the FREQUENCY ADJ control which varies the electrical length of the cavity and thereby the frequency of oscillation.

Positive feedback, required for oscillation, is accomplished by coupling a portion of the output signal back into the grid cavity. RF energy is coupled from the cavity to the output cable with a probe which acts as an adjustable capacitance. Varying the depth of probe insertion with the OUTPUT COUPLING control varies the capacitance and therefore the portion of the signal applied to the output. Excessive coupling reduces the positive feedback and efficiency of the oscillator, thereby reducing the output power and, at the same time, increasing plate current. Excessive coupling is to be avoided during operation.

C ~~D~~.4.2 Thermal Sensors

Thermal sensors S1 and S2 are mounted on the cavity body to detect overtemperature conditions. S1 closes at a temperature of 175 degrees F and activates the TEMP warning circuit on the System Control P.C. board. S2 operates at a temperature of 185 degrees F and activates the TEMP shutdown circuit. The two switches have a high degree of hysteresis and once closed, will not open until the cavity body temperature drops below approximately 100 degrees F.

C ~~D~~.4.3 Meter Amplifier and High VSWR Detector Circuits

A complete description of these circuits is given in paragraphs 4.1.8 and 4.2.4 of this manual.

C ~~D~~.5 Maintenance

C ~~D~~.5.1 Test and Alignment

Test and alignment of the plug-in assembly can be performed only when it is installed in an EP250C main frame. See Section V, paragraphs 5.1 and 5.2, for Test and Alignment procedures.

C ~~D~~.5.2 Subassembly Replacement

The Meter Amplifier P.C. board and the Power Sensor Z1 are the two replaceable subassemblies.

C ~~D~~.5.2.1 Meter Amplifier P.C. Board Replacement

The Meter Amplifier P.C. board is replaced as described in the following steps.

a. Disconnect the cable connectors from P1 of the P.C. board assembly.

b. Remove the four nuts and washers holding the board assembly to the wall of the chassis.

c. To install the replacement board, follow the preceding steps in the reverse order.

C ~~D~~.5.2.2 Power Sensor Replacement

Power Sensor Replacement is described in the following steps.

a. With the plug-in assembly inverted, disconnect the RF cable from the INPUT connector of the sensor.

b. Remove the nut holding the RF OUT connector on the front panel of the plug-in assembly.

c. Mark the leads for future installation, then unsolder the leads from the REF, FOR, and GND terminals of the sensor.

d. Remove the mounting screws holding the sensor to the chassis.

e. Remove the sensor.

f. Install the replacement sensor by following the preceding steps in the reverse order.

C~~D~~.5.3 Component Replacement

The only field-replaceable components in the unit (other than wires and cables) are the two temperature sensors and the oscillator tube.

C~~D~~.5.3.1 Temperature Sensor Replacement

Temperature sensor replacement is accomplished by unsoldering the leads from the terminals of the sensor to be replaced and unscrewing the sensor from the cavity body.

When installing the replacement sensor, either terminal may be connected to the output or ground lead.

C~~D~~.5.3.2 Oscillator Tube Replacement

Replace the oscillator tube as described in the following steps.

a. Facing the rear of the plug-in, remove the three screws holding the tube cover to the body of the cavity.

b. Remove the tube cover from the tube.

c. Remove the tube from the cavity body by pulling it straight out.

d. Install the new tube by following the preceding steps in the reverse order.

Note

It is not necessary to retune or readjust the cavity when the tube is replaced.

APPENDIX D

D.0 CAVITY OSCILLATOR ASSEMBLY, PLUG-IN
Model M8060H

D.1 General

The plug-in cavity oscillator assembly consists of a high-power oscillator stage, RF power detector, meter amplifier P.C. board assembly, and thermal sensors.

The plug-in assembly covers the frequency range of 700 to 1200 MHz, with the operating frequency being controlled by the FREQUENCY ADJ control on the front panel. The RF output, available at the RF OUT connector, can be varied from less than 20 watts to greater than 225 watts throughout the frequency range. The maximum output power available varies with frequency and differs slightly from unit to unit.

Figure D-1 is a graph of the maximum output power vs. frequency for the average cavity. It should be noted that when the power level is set to maximum, the output ripple may exceed the level given in the Table of Specifications (Section I, Table 1-1).

A complete list of specifications for this plug-in is given in Table D-1.

D.2 Installation

The plug-in assembly is installed in the EP250C Power Source main frame as described in the following steps.

a. Set the rear of the plug-in chassis on the two mounting brackets in the plug-in chamber and push the plug-in straight back.

b. Be sure that the rear of the plug-in front panel is flush against the front panel of the main frame.

c. Tighten the two captive screws at the bottom of the plug-in front panel finger-tight. The installation is complete.

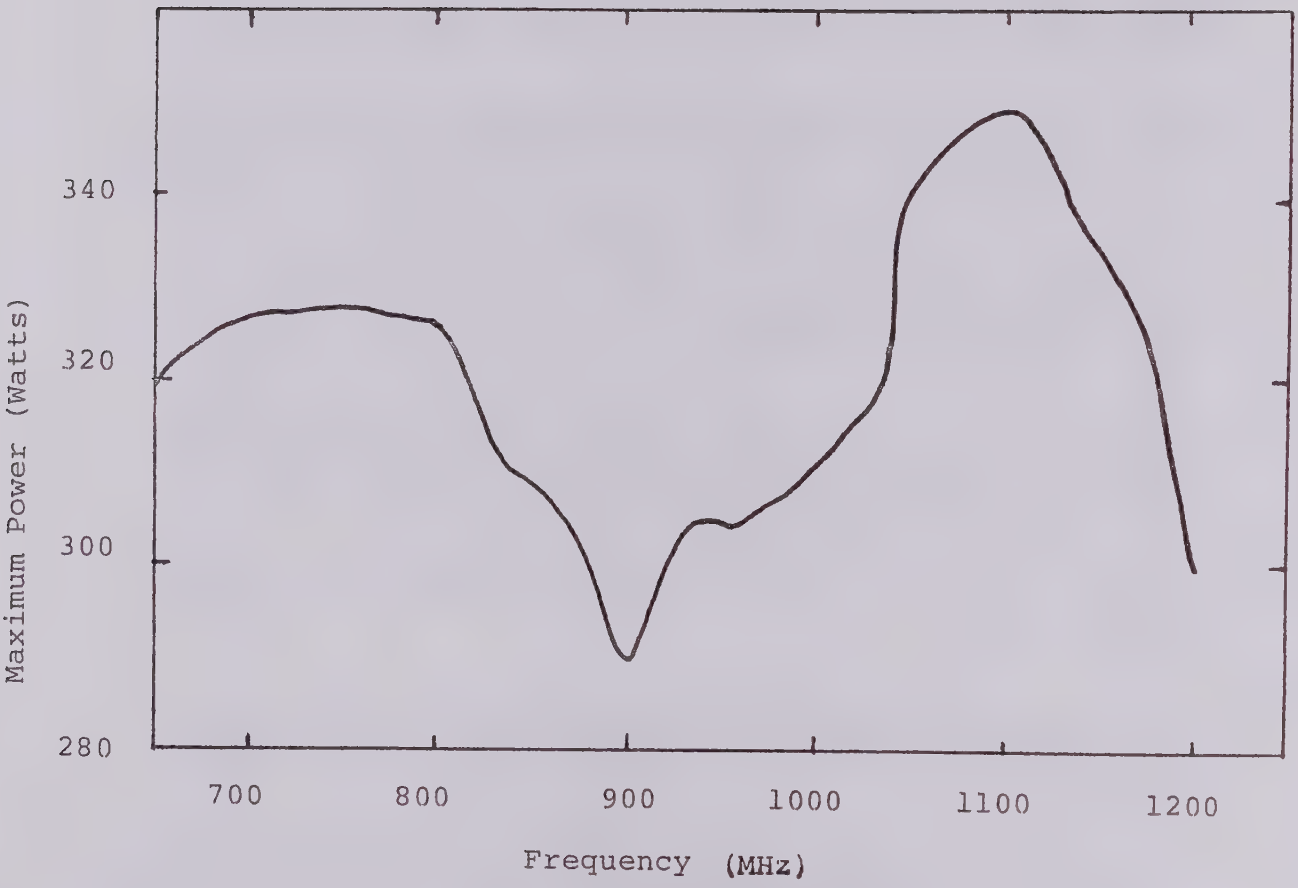


Figure D-1. RF Output vs Frequency
Typical Model M8060H

Table D-1. Model M8060H Specifications

FREQUENCY	
Range	700 to 1200 MHz
Stability	0.04%/hr. under constant conditions
Reset Accuracy	0.5%
POWER	
Input	-2000 VDC max at 0.5 Amperes max.
Output	225 watts min with LEVEL set to maximum
Stability	0.1 dB/hr.
Output Range	10 dB minimum
LOAD REQUIREMENTS	
Impedance	50 ohms
VSWR	1.7 to 1 maximum at full rated power

WARNING

NEVER REMOVE A PLUG-IN ASSEMBLY WHILE THE EP250C POWER SOURCE IS IN THE RF ON MODE OF OPERATION.

d. The plug-in is removed by performing the preceding steps in the reverse order.

No electrical alignment or adjustment is necessary if the plug-in assembly is always used with the same main frame.

Note

If a plug-in is to be used in two or more models of main frames, power meter zero adjustments may be necessary to insure that the RF POWER meter reads within specifications. See Section V of this manual.

D.3 Operation

Operating instructions for the M8045H plug-in assembly are given in Section III of this manual. When the Model M8060H plug-in is installed, the same procedures apply except that references to frequency must take into account the operating range of the Model M8060H oscillator.

D.4 Theory of Operation

The following paragraphs, in conjunction with paragraphs 4.1 and 4.2 of this manual, form a complete description of the operation of the Model EP250C Power Source with a Model M8060H plug-in oscillator assembly installed. Figure D-2 is a schematic diagram of the plug-in assembly. All references to the plug-in assembly in Section IV of this manual apply with the exception of frequency.

D.4.1 Cavity Oscillator

The plug-in assembly uses a triode vacuum tube as the source of RF signals. The plate of the tube is grounded

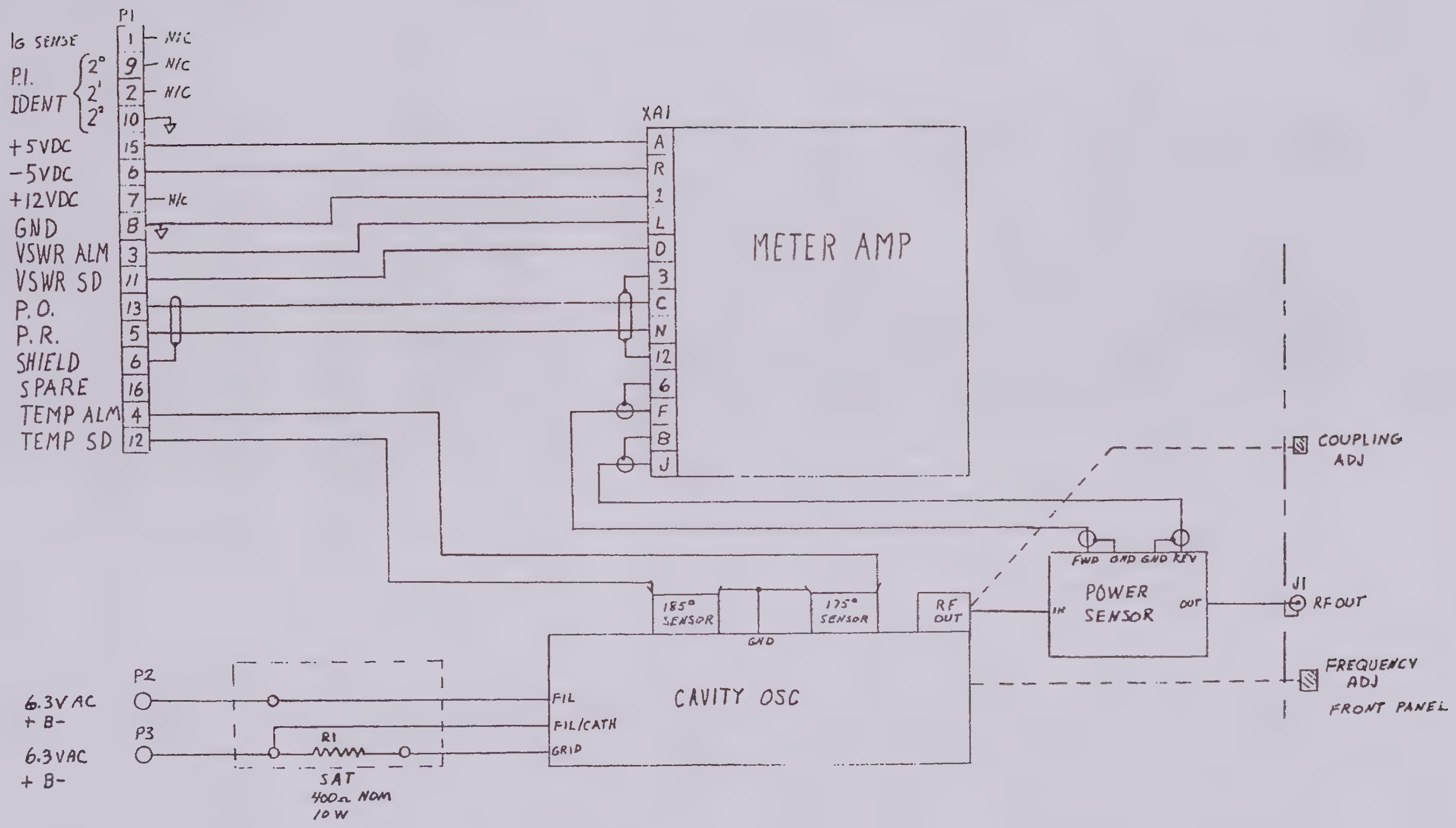

P1
IG SENSE
P.I. IDENT
2°
2¹
2²
+5VDC
-5VDC
+12VDC
GND
VSWR ALM
VSWR SD
P.O.
P.R.
SHIELD
SPARE
TEMP ALM
TEMP SD
1
9
2
10
15
6
7
8
3
11
13
5
6
16
4
12
N/C
N/C
N/C
N/C
XA1
A
R
1
L
D
3
C
N
12
6
F
B
J
METER AMP
COUPLING ADJ
FWD
GND
GND
REV
POWER SENSOR
IN
OUT
J1
RF OUT
185° SENSOR
175° SENSOR
GND
RF OUT
FREQUENCY ADJ
FRONT PANEL
CAVITY OSC
FIL
FIL/CATH
GRID
P2
6.3VAC
+ B-
P3
6.3VAC
+ B-
R1
SAT
400Ω NOM
10W

Figure D-2. Schematic Diagram - Model M8060H Plug-In Cavity Oscillator Assembly

through the cavity body. The tube is powered by a negative voltage from the High-Voltage Power Supply (HVPS) which is connected via the filament transformer on the main frame of the instrument. The negative DC voltage and the 6.3 VAC filament voltage are connected via common leads to the tube cathode/filament connections through the hollow cavity body. The oscillator is self-biased with R1 providing the grid-to-cathode connection. The coaxial grid anode and cathode cavities form tuned circuits at a frequency determined by the physical length of cavities. This length is adjusted by the FREQUENCY ADJ control which varies the electrical length of the cavity and thereby the frequency of oscillation.

Positive feedback, required for oscillation, is accomplished by coupling a portion of the output signal back into the grid cavity. RF energy is coupled from the cavity to the output cable with a probe which acts as an adjustable capacitance. Varying the depth of probe insertion with the OUTPUT COUPLING control varies the capacitance and therefore the portion of the signal applied to the output. Excessive coupling reduces the positive feedback and efficiency of the oscillator, thereby reducing the output power and, at the same time, increasing plate current. Excessive coupling is to be avoided during operation.

D.4.2 Thermal Sensors

Thermal sensors S1 and S2 are mounted on the cavity body to detect overtemperature conditions. S1 closes at a temperature of 175 degrees F and activates the TEMP warning circuit on the System Control P.C. board. S2 operates at a temperature of 185 degrees F and activates the TEMP shutdown circuit. The two switches have a high degree of hysteresis and once closed, will not open until the cavity body temperature drops below approximately 100 degrees F.

D.4.3 Meter Amplifier and High VSWR Detector Circuits

A complete description of these circuits is given in paragraphs 4.1.8 and 4.2.4 of this manual.

D.5 Maintenance

D.5.1 Test and Alignment

Test and alignment of the plug-in assembly can be performed only when it is installed in an EP250C main frame. See Section V, paragraphs 5.1 and 5.2, for Test and Alignment procedures.

D.5.2 Subassembly Replacement

The Meter Amplifier P.C. board and the Power Sensor Z1 are the two replaceable subassemblies.

D.5.2.1 Meter Amplifier P.C. Board Replacement

The Meter Amplifier P.C. board is replaced as described in the following steps.

a. Disconnect the cable connectors from P1 of the P.C. board assembly.

b. Remove the four nuts and washers holding the board assembly to the wall of the chassis.

c. To install the replacement board, follow the preceding steps in the reverse order.

D.5.2.2 Power Sensor Replacement

Power Sensor Replacement is described in the following steps.

a. With the plug-in assembly inverted, disconnect the RF cable from the INPUT connector of the sensor.

b. Remove the nut holding the RF OUT connector on the front panel of the plug-in assembly.

c. Mark the leads for future installation, then unsolder the leads from the REF, FOR, and GND terminals of the sensor.

d. Remove the mounting screws holding the sensor to the chassis.

e. Remove the sensor.

f. Install the replacement sensor by following the preceding steps in the reverse order.

D.5.3 Component Replacement

The only field-replaceable components in the unit (other than wires and cables) are the two temperature sensors and the oscillator tube.

D.5.3.1 Temperature Sensor Replacement

Temperature sensor replacement is accomplished by unsoldering the leads from the terminals of the sensor to be replaced and unscrewing the sensor from the cavity body.

When installing the replacement sensor, either terminal may be connected to the output or ground lead.

D.5.3.2 Oscillator Tube Replacement

Replace the oscillator tube as described in the following steps.

a. Facing the rear of the plug-in, remove the three screws holding the tube cover to the body of the cavity.

b. Remove the tube cover from the tube.

c. Remove the tube from the cavity body by pulling it straight out.

d. Install the new tube by following the preceding steps in the reverse order.

Note

It is not necessary to retune or readjust the cavity when the tube is replaced.

APPENDIX ~~D~~ E

E ~~D~~.0 CAVITY OSCILLATOR ASSEMBLY, PLUG-IN
Model M80~~60~~ 70 H

E ~~D~~.1 General

The plug-in cavity oscillator assembly consists of a high-power oscillator stage, RF power detector, meter amplifier P.C. board assembly, and thermal sensors.

The plug-in assembly covers the frequency range of ~~700~~ 1000 to ~~1200~~ 2000 MHz, with the operating frequency being controlled by the FREQUENCY ADJ control on the front panel. The RF output, available at the RF OUT connector, can be varied from less than 20 watts to greater than 225 watts throughout the frequency range. The maximum output power available varies with frequency and differs slightly from unit to unit.

Figure ~~D~~ E-1 is a graph of the maximum output power vs. frequency for the average cavity. It should be noted that when the power level is set to maximum, the output ripple may exceed the level given in the Table of Specifications (Section I, Table 1-1).

A complete list of specifications for this plug-in is given in Table ~~D~~ E-1.

E D.2 Installation

The plug-in assembly is installed in the EP250C Power Source main frame as described in the following steps.

a. Set the rear of the plug-in chassis on the two mounting brackets in the plug-in chamber and push the plug-in straight back.

b. Be sure that the rear of the plug-in front panel is flush against the front panel of the main frame.

c. Tighten the two captive screws at the bottom of the plug-in front panel finger-tight. The installation is complete.

Figure E-1. RF Output Frequency Curve

Table ~~D~~E-1. Model M80~~60~~70H Specifications

FREQUENCY

Range	~~700~~ 1000 to ~~1200~~ 2000 MHz
Stability	0.04%/hr. under constant conditions
Reset Accuracy	0.5%

POWER

Input	-2000 VDC max at 0.5 Amperes max.
Output	225 watts min with LEVEL set to maximum
Stability	0.1 dB/hr.
Output Range	10 dB minimum

LOAD REQUIREMENTS

Impedance	50 ohms
VSWR	1.7 to 1 maximum at full rated power

WARNING

NEVER REMOVE A PLUG-IN ASSEMBLY WHILE THE EP250C POWER SOURCE IS IN THE RF ON MODE OF OPERATION.

d. The plug-in is removed by performing the preceding steps in the reverse order.

No electrical alignment or adjustment is necessary if the plug-in assembly is always used with the same main frame.

Note

If a plug-in is to be used in two or more models of main frames, power meter zero adjustments may be necessary to insure that the RF POWER meter reads within specifications. See Section V of this manual.

~~D~~E.3 Operation

Operating instructions for the M8045H Plug-In assembly are given in Section III of this manual because it is the most commonly used plug-in. When the Model M8070H plug-in is installed, the same procedures apply except that the references to frequency must take into account the operating range of the Model M8070H oscillator.

~~D~~E.4 Theory of Operation

The following paragraphs, in conjunction with paragraphs 4.1 and 4.2 of this manual, form a complete description of the operation of the Model EP250C Power Source with a Model M80~~60~~H plug-in oscillator assembly installed. 70 Figure ~~D~~E-2 is a schematic diagram of the plug-in assembly. All references to the plug-in assembly in Section IV of this manual apply with the exception of frequency.

~~D~~E.4.1 Cavity Oscillator

The plug-in assembly uses a triode vacuum tube as the source of RF signals. The plate of the tube is grounded

Figure E-2. Schematic Diagram - Model M8070H
Plug-In Cavity Oscillator Assembly

through the cavity body. The tube is powered by a negative voltage from the High-Voltage Power Supply (HVPS) which is connected via the filament transformer on the main frame of the instrument. The negative DC voltage and the 6.3 VAC filament voltage are connected via common leads to the tube cathode/filament connections through the hollow cavity body. The oscillator is self-biased with R1 providing the grid-to-cathode connection. The coaxial grid anode and cathode cavities form tuned circuits at a frequency determined by the physical length of cavities. This length is adjusted by the FREQUENCY ADJ control which varies the electrical length of the cavity and thereby the frequency of oscillation.

Positive feedback, required for oscillation, is accomplished by coupling a portion of the output signal back into the grid cavity. RF energy is coupled from the cavity to the output cable with a probe which acts as an adjustable capacitance. Varying the depth of probe insertion with the OUTPUT COUPLING control varies the capacitance and therefore the portion of the signal applied to the output. Excessive coupling reduces the positive feedback and efficiency of the oscillator, thereby reducing the output power and, at the same time, increasing plate current. Excessive coupling is to be avoided during operation.

E~~D~~.4.2 Thermal Sensors

Thermal sensors S1 and S2 are mounted on the cavity body to detect overtemperature conditions. S1 closes at a temperature of 175 degrees F and activates the TEMP warning circuit on the System Control P.C. board. S2 operates at a temperature of 185 degrees F and activates the TEMP shutdown circuit. The two switches have a high degree of hysteresis and once closed, will not open until the cavity body temperature drops below approximately 100 degrees F.

E~~D~~.4.3 Meter Amplifier and High VSWR Detector Circuits

A complete description of these circuits is given in paragraphs 4.1.8 and 4.2.4 of this manual.

E ~~D~~.5 Maintenance

E ~~D~~.5.1 Test and Alignment

Test and alignment of the plug-in assembly can be performed only when it is installed in an EP250C main frame. See Section V, paragraphs 5.1 and 5.2, for Test and Alignment procedures.

E ~~D~~.5.2 Subassembly Replacement

The Meter Amplifier P.C. board and the Power Sensor Z1 are the two replaceable subassemblies.

E ~~D~~.5.2.1 Meter Amplifier P.C. Board Replacement

The Meter Amplifier P.C. board is replaced as described in the following steps.

a. Disconnect the cable connectors from P1 of the P.C. board assembly.

b. Remove the four nuts and washers holding the board assembly to the wall of the chassis.

c. To install the replacement board, follow the preceding steps in the reverse order.

E ~~D~~.5.2.2 Power Sensor Replacement

Power Sensor Replacement is described in the following steps.

a. With the plug-in assembly inverted, disconnect the RF cable from the INPUT connector of the sensor.

b. Remove the nut holding the RF OUT connector on the front panel of the plug-in assembly.

c. Mark the leads for future installation, then unsolder the leads from the REF, FOR, and GND terminals of the sensor.

d. Remove the mounting screws holding the sensor to the chassis.

e. Remove the sensor.

f. Install the replacement sensor by following the preceding steps in the reverse order.

E ~~D~~.5.3 Component Replacement

The only field-replaceable components in the unit (other than wires and cables) are the two temperature sensors and the oscillator tube.

E ~~D~~.5.3.1 Temperature Sensor Replacement

Temperature sensor replacement is accomplished by unsoldering the leads from the terminals of the sensor to be replaced and unscrewing the sensor from the cavity body.

When installing the replacement sensor, either terminal may be connected to the output or ground lead.

E ~~D~~.5.3.2 Oscillator Tube Replacement

Replace the oscillator tube as described in the following steps.

a. Facing the rear of the plug-in, remove the three screws holding the tube cover to the body of the cavity.

b. Remove the tube cover from the tube.

c. Remove the tube from the cavity body by pulling it straight out.

d. Install the new tube by following the preceding steps in the reverse order.

Note

It is not necessary to retune or readjust the cavity when the tube is replaced.

APPENDIX F

F.0 MAGNETRON OSCILLATOR ASSEMBLY, PLUG-IN
Model M8080H

F.1 General

The Model M8080H plug-in, when installed in an EP250C Power Source, provides a cw output at approximately 2450 MHz. The output frequency is fixed in that it is not directly operator-controllable. The exact output frequency is dependent on the power level and load. The output power level is adjustable over the range of 100 to 250 watts. Although stable operation can generally be obtained at levels as low as 50 watts, operation below the 100-watt level is not guaranteed.

The Model M8080H Plug-In consists of a fixed frequency oscillator and the boost power supply necessary to raise the 2 KV (maximum) output of the EP250C to the level required for magnetron operation. An output and reflected power sensor is also included in the plug-in for monitoring the oscillator output and load conditions.

The M8080H is designed to fit into the plug-in space of an EP250C power source. Shrouds and baffles in the plug-in direct cooling air from the main frame over the heat-producing components of the M8080H.
All high-voltage points above the chassis of the plug-in are shielded for safety.

Table F-1. Model M8080H Specifications

Frequency (250-watt output and load VSWR of 1.05:1 or less)	2440 to 2470
Maximum Power Output	250 watts
Minimum Power Output	100 watts
Input Power Requirements	
115 V, 60 Hz, AC at 4 amperes	
-2000 VDC at 0.2 amperes	

F.2 Installation

Before installing the magnetron in the EP250C power source:

a. Check that the jumpers on T1 are connected properly for the line voltage in use. Refer to Figure F-1 for connections.

b. Check that the AC line fuse F1 is of the proper value for the intended voltage to be applied.
For 115V operation: F1 = 6A
For 230V operation: F1 = 3A

c. Check that the input power connections to the Power Transformer T1 are correct for prevailing line voltage conditions. Refer to paragraph F.5.1.2 for list of connections.

d. With the EP250C MAIN POWER switch set to OFF, slide the M8080H into the cavity cutout until the knurled locking screws make contact.

e. Tighten the two screws by hand until the front panel of the M8080H is flush against the front panel of the EP250C Power Source.

f. The installation is complete.

F.3 Operation

With the exceptions described in this paragraph, the operating instructions given in Section 5 of this manual are valid for use when the M8080H plug-in is installed.

a. The output frequency is fixed within the range of 2440 to 2470 MHz. Some small frequency variations will occur (usually less than 5 MHz) as the output power is varied from 100 to 250 W.

b. When the instrument is first turned on, the maximum output power may be below the specified 250W. The power output will increase rapidly as the magnetron heats. Normal operating temperature will be reached in 5 to 10 minutes.

c. When the output power reaches the desired setting, adjust the RF LEVEL control as necessary to maintain the desired level (two or three corrections may be necessary during the first five minutes of operation at a new power setting before temperature stabilizes).

CAUTION

Operating the unit at maximum output level (greater than 250W) may reduce tube life.

F.4 Theory of Operation (Refer to Schematic Diagram, Figure F-1)

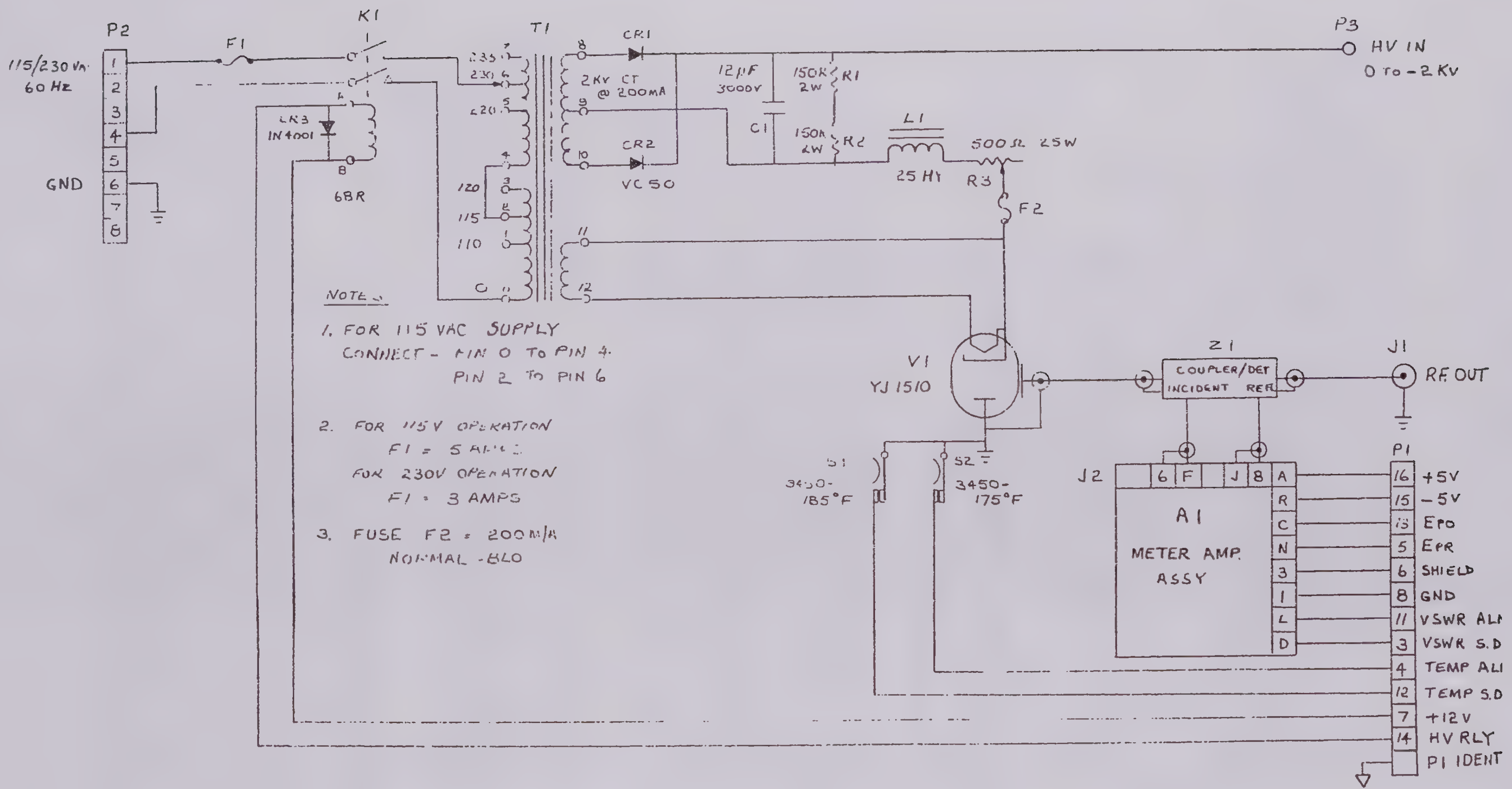
F.4.1 Magnetron Oscillator

The major component of the M8080H plug-in is the magnetron oscillator tube V1. Whenever sufficient d-c voltage is applied between the cathode and anode of the device, RF oscillations are produced at its output terminal. The frequency of oscillation is determined mainly by internal construction of the tube and, to a much lesser extent, by the average anode current. Output power level is primarily a function of the anode current.

The tube does not conduct with anode-to-cathode voltages of less than approximately 2700 volts. A small increase in voltage above this threshold level causes the anode current to increase rapidly to its normal operating value of approximately 150 ma. At this current level, a nominal output of 250 W is obtained.

F.4.2 Auxiliary Power Supply

Since the maximum output voltage of the EP250C power supply is 2000 volts, the plug-in contains an auxiliary supply which provides approximately 800 volts dc. This supply is connected in series with the supply in the EP250C main frame to provide a total of up to 3000 volts for magnetron operation. The auxiliary supply voltage source is a power transformer T1 with a secondary winding which provides approximately


P2
115/230 VAC
60 Hz
1
2
3
4
5
6
7
8
GND
F1
K1
CR3
IN4001
A
B
6BR
T1
235
230
220
120
115
110
0
2KV CT
@ 200MA
CR1
CR2
VC50
8
9
10
11
12
12 µF
3000V
C1
150K
2W
R1
150K
2W
R2
L1
25 HY
500 Ω 25W
R3
F2
P3
HV IN
0 TO -2 KV
V1
YJ 1510
S1
3450-
185°F
S2
3450-
175°F
Z1
COUPLER/DET
INCIDENT REF
J1
RF OUT
J2
6
F
J
8
A1
METER AMP.
ASSY
A
R
C
N
3
1
L
D
P1
16 +5V
15 -5V
13 EPO
5 EPR
6 SHIELD
8 GND
11 VSWR AL
3 VSWR S.D
4 TEMP AL
12 TEMP S.D
7 +12V
14 HV RLY
P1 IDENT

NOTES

1. FOR 115 VAC SUPPLY
CONNECT - PIN 0 TO PIN 4.
PIN 2 TO PIN 6

2. FOR 115V OPERATION
F1 = 5 AMPS
FOR 230V OPERATION
F1 = 3 AMPS

3. FUSE F2 = 200 MA
NORMAL - BLO

2450 MHz MAGNETRON OSCILLATOR
EP250 C PLUG IN M8080
SCHEMATIC

Figure F-1

2/12/81

1900 volts RMS and is center-tapped. This supply is not regulated, and with a constant RF LEVEL setting, the output power will vary directly with input voltage. The 0.25-ampere fuse F2 in the high-voltage line is designed to prevent tube damage in the event of line surges.

The high voltage output of T1 is rectified by CR1 and CR2 and filtered by C1 and L1. Resistors R1 and R2 provide a discharge path for C1 when primary power is removed. A filament supply of 4 volts ac at 17 amperes is obtained from a separate secondary winding on T1. R3, which provides isolation between the supply and the magnetron, is adjustable to allow setting the maximum anode current to a safe level. R4 isolates the auxiliary supply from the EP250C supply.

Taps on the primary of T1 allow ±5% variation in output level to compensate for high or low voltage conditions.

F.4.3 Monitor and Control Circuits

The auxiliary supply is turned on and off in time with the main frame power supply. Primary power to T1 is switched by K1, which in turn is controlled by the RF ON/OFF control circuits of the EP250C Power Source. The instant heating filament circuit of the magnetron allows simultaneousapplication of filament and cathode voltages to the tube. Thermal sensors SW1 and SW2 provide the operator with an indication of an impending overheat condition of the magnetron temperature exceeds 175°F. The RF output power and reflected power levels are detected by the Power Detector Z1. The outputs of the Detector (0 to +0.5 VDC for incident power and 0 to 0.05 VDC for reflected power) are applied to the Meter Amplifier Assembly for processing. The levels are converted to correspond to the power level in watts for metering and are compared for high VSWR detection purposes. Operation of the Meter Amplifier circuits is described in Section 4 of this manual. The Meter Amplifier for this plug-in differs only in that the value of the gain control resistors reflect the higher input voltages.

F.5 Maintenance

F.5.1 Alignment and Adjustment

F.5.1.1 Current Limiting Adjustment

a. Set the adjustment clip on R3 for maximum resistance and tighten the screw.

b. Install the plug-in in an EP250C main frame and connect an appropriate RF load at the RF OUTPUT connector J1.

c. Connect a DVM to the Ip test point on the System Control card (refer to Figure 5-6 for its location) and replace the top cover of the instrument.

d. Turn the unit on and after Time In, set the EP250C to the RF ON mode with the RF LEVEL control fully ccw.

e. Slowly advance the setting of the RF LEVEL control while observing the DVM.

CAUTION

If the DVM reading is allowed to exceed +0.400 VDC, magnetron life may be reduced.

f. Check for an RF output power level of at least 250 watts and a DVM reading of 0.300 to 0.390 volts when the RF LEVEL control is fully cw.

Note

The magnetron is very sensitive to internal temperature variations. Continue to readjust RF LEVEL as necessary to maintain a 250 W output (output level will tend to increase with time until temperature stabilizes - approximately 10 minutes).

Note

R3 may be hot to the touch if power has been applied for any length of time.

F.5.1.3 Meter Amplifier Adjustment

This adjustment should be checked at each calibration interval and whenever one of the detector diodes of the Power Detector is replaced. The adjustment procedure is given in Paragraph 5.2.2 of this manual.

F.5.2 Component Replacement

Detector Diode Replacement

a. Unscrew the cap holding the defective diode in the Power Detector.

b. Using fingers or a small pair of long nose pliers, remove the defective diode.

Note

Be sure that the replacement diode is an "R" type; i.e., positive voltage output.

c. Holding the replacement diode by the flanged end, ground the flanged end to the body of the Power Sensor to remove any static charge before seating the diode in its holder.

d. Reinstall the cap over the diode to complete the installation.

e. Perform the Meter Amplifier Adjustment procedure (para. 5.2.2) before returning the unit to service.

g. If the maximum setting of the RF LEVEL control is reached and the RF output power is less than 250 watts, shut the system down.

h. Allow at least one minute for C1 to fully discharge, then measure the resistance of R3.

i. Loosen the screw on the adjustable terminal of R3 and move the terminal until the resistance is reduced by 25 to 30 ohms.

j. Repeat steps d through i until the requirements of step f are met.

F.5.1.2 Input Power Wiring

Table F-1 illustrates the various wiring combinations that can be used to power T1 allowing use of the plug-in at high, normal, and low line voltages at 115V or 230V nominal values.

Table F-1. T1 Primary Connections

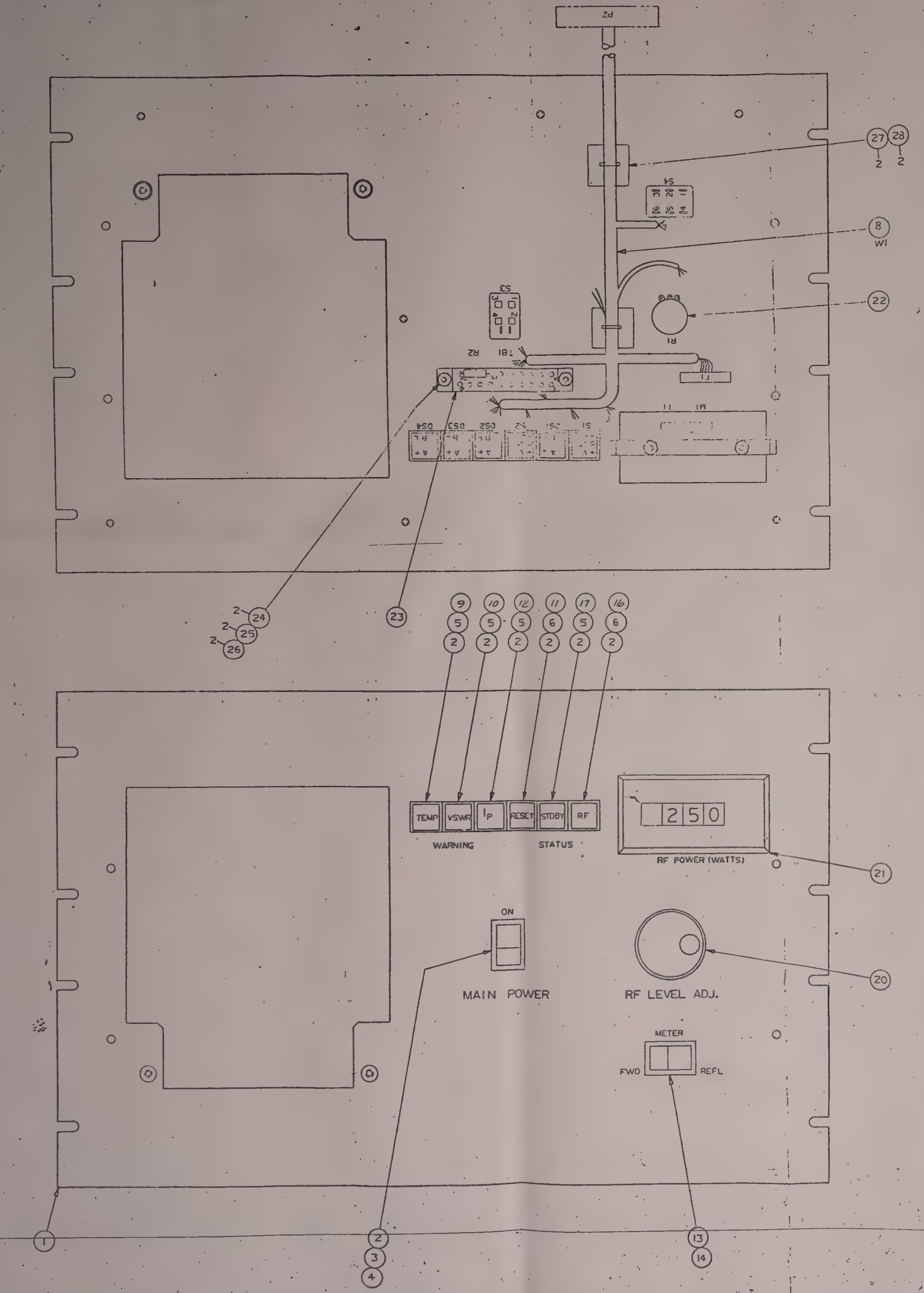
Primary Voltage	Input Lead (black)	Jumper(s)	
		From	To
115			
< 110	5	5	1
		0	4
110 to 120	6	6	2
		0	4
> 120	7	7	3
		0	4
230			
< 225	5	4	1
225 to 235	6	4	2
> 235	7	4	3

Table F-2

Replacable Parts List - Model M8080H Plug-In

Ref. Des.	Description	Mfr.	P/N
A1	Meter Amplifier Assembly	EPSCO	2069-0026G1
C1	Capacitor, 12MFD, 3KV	Plastic Capacitors	LK30-125Z
CR1,CR2	Rectifier, 2KV, 0.5A		3HAS13159
CR3	Diode, Rectifier		1N4001
F1	Fuse, 3AG(See Fig. 6-1 for value)		
F2	Fuse, 3AG, 0.25A		
J1	Connector, RF		UG-30D/U
J2	Connector, Female, Card Edge	AMP	2VH15/1AN5
K1	Relay, 3PDT, 12VDC	Sigma	68R3412DC-SCO
L1	Coil, 25H, 200 ma	EPSCO	6837
P1	Connector, 16-pin male	AMP	
P2	Connector, 8-pin male	AMP	
P3	Connector, HV, male	AMP	
R1,R2	Resistor, 150Kohm ±5%,2W		RC42BX154J
R3	Resistor, Adjustable, 500 ohm, 25 watt	Ohmite	Type 210, 500 ohm
S1	Thermostat, N.O., 185°	Elmwood Sensors	150-22-182 185°
S2	Thermostat, N.O., 175°	Elmwood Sensors	150-22-184 175°
T1	Transformer, Power	EPSCO	6868
V1	Electron Tube, Megatron	Amperex	YJ1510
W1,W2	Cable, RF	EPSCO	2069- ????
Z1	Sensor, RF Power	CMC	
Z1CR1, Z1CR2	Diode, Detector		1N23R

ZONE	LTR	DESCRIPTION	DATE	APPROVED
—	A	RELEASED FOR PRODUCTION	1/15/	
	B	Rev per ECO LOS CK-22		


P2
27
28
2
2
8
W1
S4
22
R1
S3
TB1
R2
M1
DS4
DS3
DS2
S2
DS1
S1
24
25
26
2
2
2
23
9
10
12
11
17
16
5
5
5
6
5
6
2
2
2
2
2
2
TEMP
VSWR
Ip
RESET
STDBY
RF
WARNING
STATUS
250
RF POWER (WATTS)
21
ON
MAIN POWER
RF LEVEL ADJ.
20
METER
FWD
REFL
1
2
3
4
13
14

NOTES.

1. FOR COMPLETE REF DES, PREFIX REF DES SHOWN WITH THE UNIT NO. & FRONT PANEL ASSY REF DES: 1A2
2. REMOVE THE MOLEX PLUG HOUSING (22-01-2121) & PIN(S)(08-50-0114) FROM ITEM 21 OF THIS ASSY. ASSEMBLE THE HOUSING & PINS AT THE 2069-2303 (FRONT PANEL DC WIRING HARNESS) ASSY LEVEL.

ITEM NO.	QTY REQD	CODE IDENT	PART OR IDENT NO.	SPECIFICATION NO.	DESCRIPTION	DWG SIZE	MATERIAL OR NOTE
29	2	16956	08350		STRAP, CABLE TIE		OR EQUIV
27	2	16956	08462		MOUNT, CABLE TIE		OR EQUIV
26	2		NO. 6		WASHER, FLAT		CRES
25	2		NO. 6		WASHER, LOCK		CRES
24	2		6-32		NUT, HEX		CRES
23	1	11873	11-[illegible]-03-005		BLOCK, TERM.		TB1
22	1	SPECTROL	830-5KΩ		POT., 3TURN		R1
21	1	07263	SH07330		METER, DIGITAL PNL		NOTE 2
20	1	21604	SSN-175-2-MATTE BLK		KNOB		
19							
18							
17	1		2069-3008 P6		BUTTON	B	
16	1		2069-3008 P5		BUTTON	B	
15	1				RES., 4.7KΩ, 1/4W		R2
14	1	74059	AML54F10K		OPERATOR, ROCKER		
13	1	74059	AML24EBA2BC03		SWITCH, ROCKER		
12	1		2069-3008 P4		BUTTON	B	
11	1		2069-3008 P3		BUTTON	B	
10	1		2069-3008 P2		BUTTON	B	
9	1		2069-3008 P1		BUTTON	B	
8	1		2069-2303		HARNESS, DC WIRING, FR PNL	E	
7	REF		2069-2400		INTERCONNECT, FR PNL		
6	2	74059	AML11CBA2AA		SWITCH, PUSHBUTTON		
5	4	74059	AML41CBA2		INDICATOR		
4	1	74059	AML56N10RK		OPERATOR, ROCKER		
3	1	74059	AML34FBA4AC01		SWITCH, ROCKER		
2	7	74059	AML91LA86		LAMP		
1	1		2069-2001		PANEL, FRONT	E	

PARTS LIST

0002		
DASH No	NEXT ASSY	USED ON

APPLICATION

*VENDOR ITEM—SEE SOURCE CONTROL OR SPECIFICATION CONTROL DRAWING

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ANGLES
.XX = .02
.XXX =
REMOVE ALL SHARP EDGES AND BURRS 1/64 MAX.
RELEASE
MATERIAL

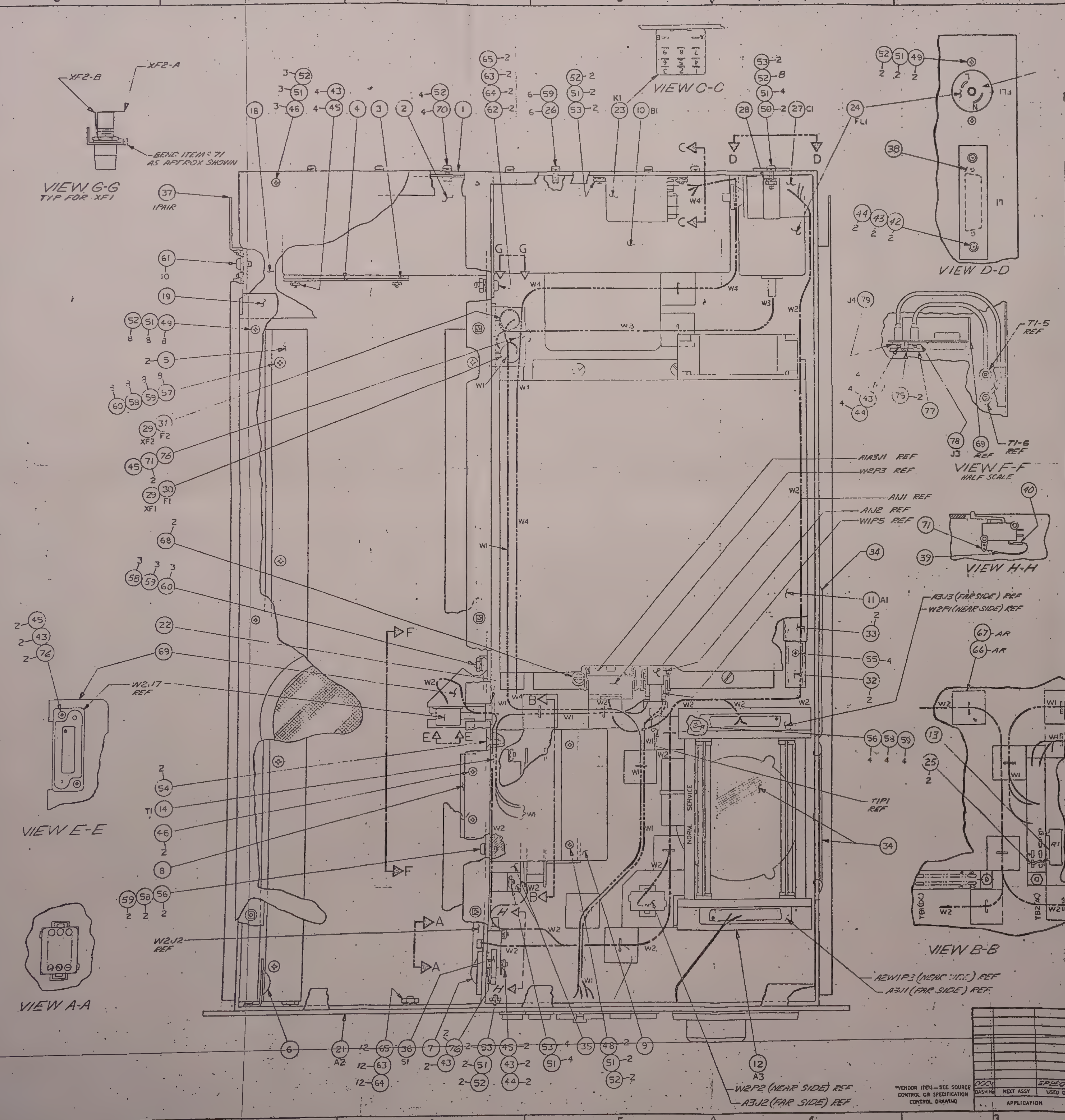
CONTRACT NO.
DRAWN D.BOYER 4/17/79
CHECKED 1-17-80
DESIGNER
ENGINEER 1/15/80
PROJECT APPROVAL 1/1/80

EPSCO INCORPORATED
411 PROVIDENCE HIGHWAY
WESTWOOD, MASS. 02090

FRONT PANEL ASSY

SIZE E
CODE IDENT NO. 99380
2069-0002 B
SCALE 1/1
SHEET 1 OF 1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED FOR PROD.		
	B	REVISED PER ECO 694 CK-22		



XF2-B
XF2-A
BEND ITEMS 71 AS APPROX SHOWN
VIEW G-G
TYP FOR XF1
1 PAIR
XF2
F2
F1
XF1
VIEW C-C
K1
B1
C1
FL1
C
D
G
W1
W2
W3
W4
VIEW D-D
J4
T1-5 REF
T1-6 REF
J3
REF
VIEW F-F
HALF SCALE
A1A3J1 REF
W2P3 REF
A1J1 REF
A1J2 REF
W1P5 REF
A3J3 (FAR SIDE) REF
W2P1 (NEAR SIDE) REF
VIEW H-H
AR
W2J7 REF
VIEW E-E
T1
TIP1 REF
SERVICE
NORM.
VIEW B-B
TB1(DC)
TB2(AC)
R1
W2J2 REF
VIEW A-A
A2W1P2 (NEAR SIDE) REF
A3J1 (FAR SIDE) REF
W2P2 (NEAR SIDE) REF
A3J2 (FAR SIDE) REF
A2
S1
A3
A1
E
F
A
B
H

—LOCATION FOR ITEM 20

NOTES

1. FOR COMPLETE REF DES, PREFIX WITH MANUAL UNIT MAIN CHASSIS ASSY REF DES: 1.
2. ITEM 74, WHICH IS NOT SHOWN, IS TO BE MOUNTED INTO THE CLIPS OF ITEM 19.

ITEM NO.	QTY REQD	CODE IDENT	PART OR IDENT NO.	SPECIFICATION NO.	DESCRIPTION	DWG SIZE	MATERIAL OR NOTE
79	1		2069-2306-P2		CABLE, HV DISCONNECT	C	J4
78	1		2069-2306-P1		CABLE, HV DISCONNECT	C	J3
77	1		2069-1005		GUIDE, DISCONNECT	B	
76	9		4-40X.44LG		SCREW, PAN HD		CRES
75	2		6-32X.50LG		SCREW, FLAT HD		CRES
74	1		2069-2044		EXTRACTOR, CARD	C	NOTE 2
73	1		2069-2305		CABLE, RELAY ↔ TERM.(AC)	D	W4
72	1		2069-2304		CABLE, LINE FILTER ↔ FUSE	C	W3
71	3	83330	1413-4		SOLDER LUG		
70	4		6-32X.44LG		SCREW, PAN HD		CRES
69	1		2069-[illegible]		BRACKET, CONN	C	
68	2		2069-1025		STUD, LOCATOR, HV/FS	B	
67	AR	16956	08350		FASTNER, CABLE TIE		OR EQUIV
66	AR	16956	08462		MOUNT, CABLE TIE		OR EQUIV
65	14		10-32		NUT, HEX		CRES
64	14		NO. 10		WASHER, FLAT		
63	14		NO. 10		WASHER, LOCK		
62	2		10-32X.50LG		SCREW, PAN HD		
61	10		10-32X.25LG		SCREW, PAN HD		
60	11		8-32		NUT, HEX		
59	23		NO.8		WASHER, FLAT		
58	17		NO.8		WASHER, LOCK		
57	8		8-32X.62LG		SCREW, FLAT HD		
56	6		8-32X.38LG		SCREW, PAN HD		
55	4		8-32X.19LG		SCREW, PAN HD		
54	2		8-32X.38LG		SCREW, FLAT HD, 82°		
53	10		6-32		NUT, HEX		
52	31		NO.6		WASHER, FLAT		
51	27		NO.6		WASHER, LOCK		
50	2		~~6-32X.50LG~~		~~SCREW, PAN HD~~		
49	10		6-32X.38LG		SCREW, PAN HD		
48	2		6-32X.31LG		SCREW, PAN HD		CRES
47							
46	5		6-32X.25LG		SCREW, FLAT HD, 82°		CRES
45	9		4-40		NUT, HEX		
44	8		NO.4		WASHER, FLAT		
43	16		NO.4		WASHER, LOCK		
42	2		4-40X.31LG		SCREW, PAN HD		CRES
41							
40	1	09769	640347-1		FASTON, .187 INSUL		
39	3 IN		NO. 22 AWG		WIRE, STRD, TEFLON, INSUL		BLK
38	1		2069-1110		COVER PLATE	B	
37	1PAIR	06666	C-230-S-124		SLIDE, CHASSIS		
36	1	01963	E34-90N		SWITCH, MINIATURE		S1
35	2	11873	18-5620-04-010		TERM. BLOCK, QUICK-CONNECT		TB1(DC), TB2(AC)
34	3	MIDGET LOUVRE	4"I.D., 6TAB		LOUVER		ALL ALUM
33	2		2069-1030		COVER, PANDUCT	B	
32	2		2069-1029		PANDUCT	C	
31	1	75915	303015		FUSE, 15 AMP, FAST/BLOW		F2
30	1	75915	314020		FUSE, 20 AMP, FAST/BLOW		F1
29	2	75915	342048L		FUSEHOLDER		XF1, XF2
28	1	06001	K9827065P21		BRACKET, OVAL		
27	1	06001	21L3404		CAP,		C1
26	6		6-32X.50LG		SCREW, PAN HD		CRES
25	2	09769	60711-1		FASTON, .187 SOLDER		
24	1	33067	C115		FILTER, POWERLINE		FL1
23	1	78277	6BRE4-120C-SCO		RELAY, DPDT		K1
22	AR	83330	2694		GROMMET, "CATERPILLAR"		
21	1		2069-0002		ASSY, FRONT PANEL	E	A2
20	1		2069-2308		POWER CORD	C	
19	1		2069-2010		LGE COVER, CHASSIS	D	
18	1		2069-1007		SM COVER, CHASSIS	C	
17	REF		2069-2408		CHASSIS INTERCONNECTIONS	D	
16	1		2069-2301		WIRING HARNESS, DC	E	W2
15	1		2069-2300		WIRING HARNESS, AC	E	W1
14	1		2069-2101		ASSY, FIL-XFORMER	C	T1
13	1	60076	1509		RESISTOR, 20Ω, 5W ±5%		R1
12	1		2069-0003		ASSY, CARD CAGE	D	A3
11	1		2069-0004		ASSY, POWER SUPPLY	E	A1
10	1		2069-2103		ASSY, BLOWER	B	B1
9	1		2069-1080		SHIELD, FIL-XFORMER, RH	C	
8	1		2069-2023		SHIELD, FIL-XFORMER, LH	C	
7	1		2069-1059		FINGERS, RH	B	
6	1		2069-1058		FINGERS, LH	B	
5	2		2069-1006		SLIDE, CAVITY	C	
4	1		2069-1014		RETAINER, PLENUM GASKET	B	
3	1		2069-1015		GASKET, PLENUM	B	
2	1		2069-2022		PLENUM	D	
1	1		2069-2000		CHASSIS, MAIN	E	

PARTS LIST

*VENDOR ITEM—SEE SOURCE CONTROL OR SPECIFICATION CONTROL DRAWING

DASH No	NEXT ASSY	USED ON
0001		EP250C

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ANGLES
.XX ± .03 ± 1°
.XXX ± .015
REMOVE ALL SHARP EDGES AND BURRS 1/64 MAX.
RELEASE
MATERIAL

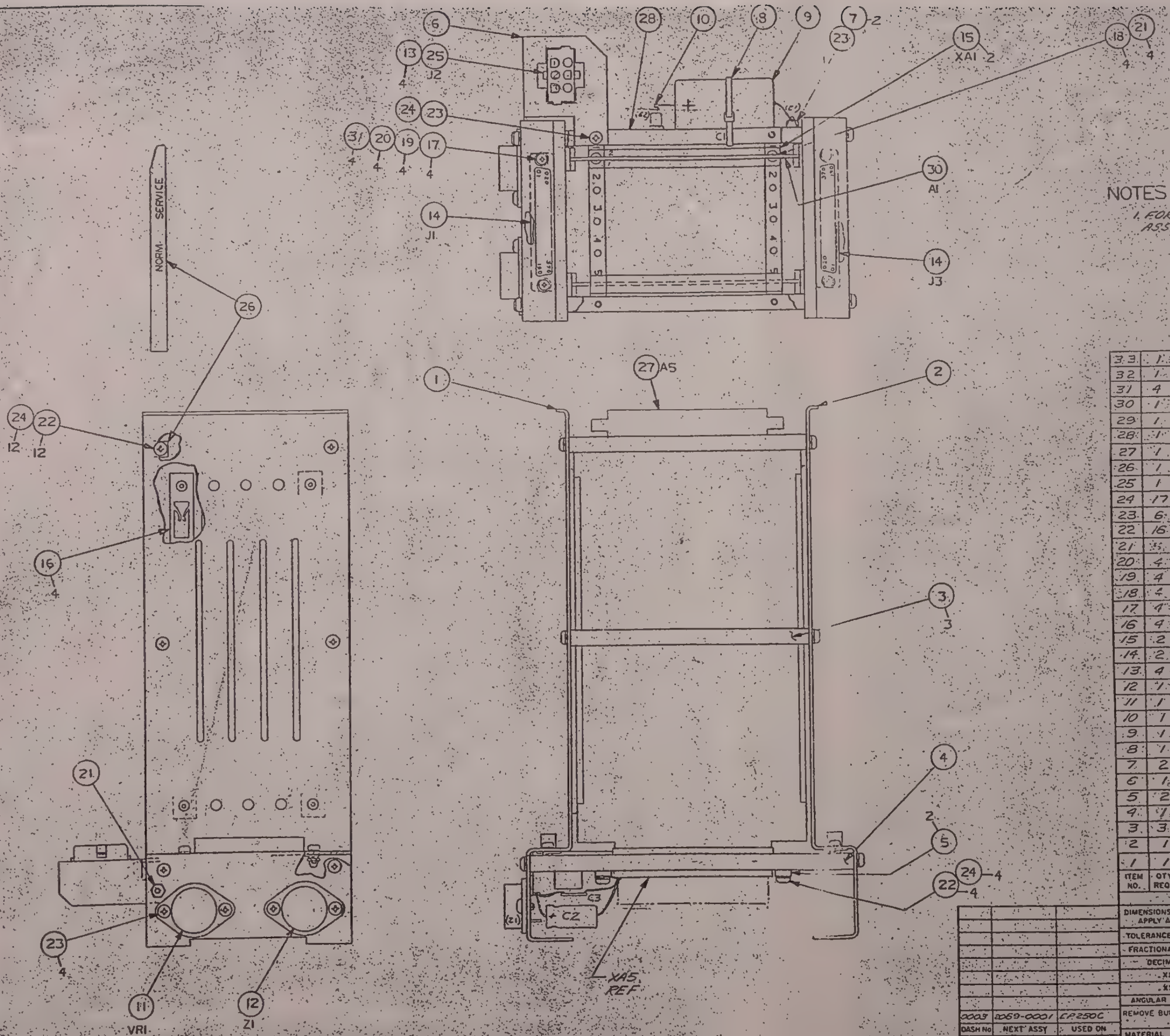
CONTRACT NO.
DRAWN D BOYER 10-16-79
CHECKED JWS 1-16-80
DESIGNER
ENGINEER
PROJECT APPROVAL

EPSCO INCORPORATED
411 PROVIDENCE HIGHWAY
WESTWOOD, MASS 02090

ASSY,
MAIN CHASSIS,
MANUAL UNIT

SIZE E
CODE IDENT NO. 99380
2069-0001
REV B
SCALE 1/1
SHEET 1 OF 1

AFFECTED	ZONE	LTR	DESCRIPTION	DATE	APPROVED
		A	RELEASED FOR PROD.		
		B	REVISED PER ECO A1	1/83	DJF
		C	REVISED PER ECO 206 *CC-22	9/3/80	



NOTES

1. FOR COMPLETE REF DES, PREFIX WITH CARD CAGE ASSY REF DES A3.

ITEM NO.	QTY REQD	CODE IDENT	PART OR IDENT NO.	SPECIFICATION NO.	DESCRIPTION	DWG SIZE	MATERIAL OR NOTE
33	1		CK06BX474K		CAP, .47uf 100V		C3
32	1	NICHICON	50ELA470		CAP, 470 uf, 50 V		C2
31	4		NO. 4		WASHER, FLAT, SMALL O.D.		CRES
30	1		2069-0023		ASSY, P/W CONTROL	D	A1
29	1		2069-2409		WRL, CARD CAGE	A	
28	1		2069-1079		BRACE, HSG, LH	B	
27	1		2069-0027		P/W ASSY, EXTENDER CARD	D	A5
26	1		2069-1010-P2		BRACE, HSG, SHORT	B	
25	1	09769	1-480705-0		CONN, UNIV MATE-N-LOK		J2
24	17		NO. 6		WASHER, LOCK		CRES
23	6		6-32 X .25 LG		SCREW, PAN HD		CRES
22	16		6-32 X .31 LG		SCREW, PAN HD		CRES
21	5	72962	59-1660-40		NUT, SELF-LOCKING, NO. 4		
20	4		4-40		NUT, HEX		CRES
19	4		NO. 4		WASHER, LOCK		
18	4		4-40 X .56 LG		SCREW, PAN HD		
17	4		4-40 X .31 LG		SCREW, PAN HD		CRES
16	4	07556	STYLE RAD6875		CARD GUIDE		
15	2	09759	3-530356-1		CONN, EDGE		XA1 + XA5
14	2	TRW CINCH	DC-37SF179		CONN, RECEPTACLE		J1, J3
13	4	09769	350690-1		CONTACT, PIN		
12	1	SIGMA	L-6-OV5		PROTECTOR, OVERVOLTAGE		OR EQUIV
11	1	SIGMA	LAS-1505 OR LM309K		REGULATOR, VOLTAGE		OR EQUIV
10	1	71279	572-4623-02		TERMINAL, INSULATED		
9	1	PANASONIC	ECEB1EV472S		CAP, 4700 UF, 25 V		C1
8	1	DENNISON	08474		CABLE TIE "EAR-LOK", 4" LG		
7	2	83330	1414-6		LUG, SOLDER		
6	1		2069-2027		BRACKET, UNIV-CONN	C	
5	2		2069-1012		SUPPORT, CONN	B	
4	1		2069-1011		BRACE, HSG, RH	B	
3	3		2069-1010-P1		BRACE, HSG, SHORT	B	
2	1		2069-2009-G2		HOUSING, CARD CASE	D	
1	1		2069-2009-G1		HOUSING, CARD CAGE	D	

LIST OF MATERIAL

DOCUMENTATION
NOV 19 1980
CONTROL

DASH No	NEXT ASSY	USED ON
0003	2069-0001	EP250C

APPLICATION

DIMENSIONS ARE IN INCHES AND APPLY AFTER PROCESSING

TOLERANCE UNLESS SPECIFIED

FRACTIONAL DIMENSIONS ±

DECIMAL DIMENSIONS

.XX ±

.XXX ±

ANGULAR DIMENSIONS ±

REMOVE BURRS AND SHARP EDGES .015 RMAX.

MATERIAL SEE P/L

CONTR. NO.

DRAWN O BOYER DATE 8-20-79

CHECKED HHS DATE 1-2-80

ELECT. ENGR DATE

MECH. ENGR DATE

APPROVED DATE

APPROVED DATE

EPSCO INCORPORATED
411 PROVIDENCE HIGHWAY
WESTWOOD, MASS. 02090

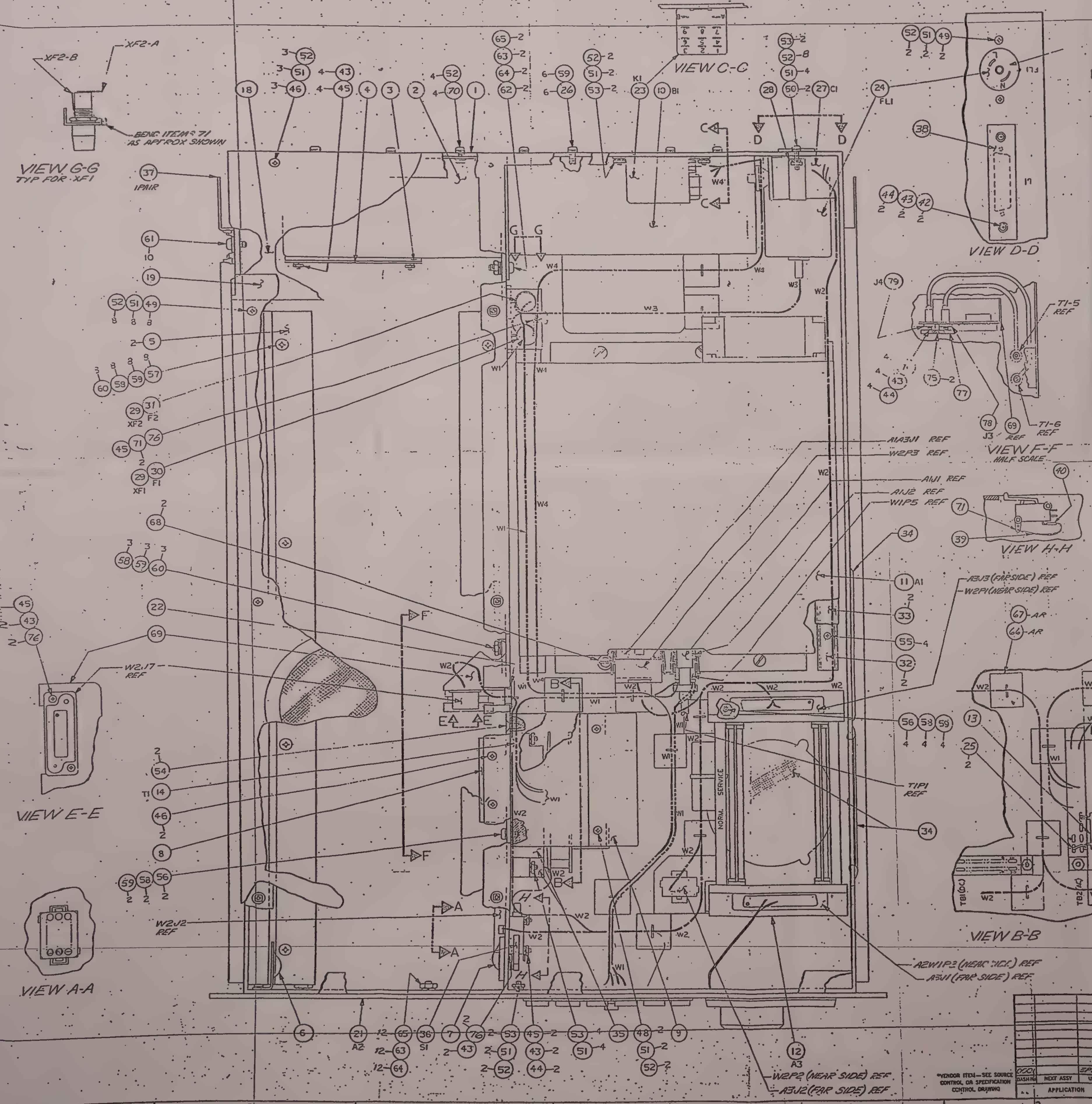
ASSY, CARD CAGE

SIZE	CODE IDENT NO.		REV
D	99380	2069-0003	C

SCALE 1/1 WT CALC ACT SHEET 1 OF 1

2069-0003

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED FOR PROD.		
	B	REVISED PER ECO LOG # CK-22		



VIEW G-G
TYP FOR XF1
XF2-B
XF2-A
BEND ITEMS 71 AS APPROX SHOWN
1PAIR
XF2
F2
XF1
F1
VIEW E-E
T1
W2J7 REF
VIEW A-A
W2J2 REF
VIEW C-C
K1
B1
C1
FL1
D
C
G
W1
W2
W3
W4
A2
S1
A3
SERVICE
NORM.
A1A3J1 REF
W2P3 REF
A1J1 REF
A1J2 REF
W1P5 REF
A3J3 (FAR SIDE) REF
W2P1 (NEAR SIDE) REF
T1P1 REF
A2W1P2 (NEAR SIDE) REF
A3J1 (FAR SIDE) REF
W2P2 (NEAR SIDE) REF
A3J2 (FAR SIDE) REF
LOCATION FOR ITEM 20
VIEW D-D
J4
J3
T1-5 REF
T1-6 REF
VIEW F-F
HALF SCALE
VIEW H-H
VIEW B-B
TB1(DC)
TB2(AC)
R1

NOTES

1. FOR COMPLETE REF DES, PREFIX WITH MANUAL UNIT MAIN CHASSIS ASSY REF DES :1.
2. ITEM 74, WHICH IS NOT SHOWN, IS TO BE MOUNTED INTO THE CLIPS OF ITEM 19.

ITEM NO.	QTY REQD	CODE IDENT	PART OR IDENT NO.	SPECIFICATION NO.	DESCRIPTION	DWG SIZE	MATERIAL OR NOTE
79	1		2069-2306-P2		CABLE, HV DISCONNECT	C	J4
78	1		2069-2306-P1		CABLE, HV DISCONNECT	C	J3
77	1		2069-1005		GUIDE, DISCONNECT	B	
76	9		4-40X.44LG		SCREW, PAN HD		CRES
75	2		6-32X.50LG		SCREW, FLAT HD		CRES
74	1		2069-2044		EXTRACTOR, CARD	C	NOTE 2
73	1		2069-2305		CABLE, RELAY ↔ TERM.(AC)	D	W4
72	1		2069-2304		CABLE, LINE FILTER ↔ FUSE	C	W3
71	3	33330	1413-4		SOLDER LUG		
70	4		6-32X.44LG		SCREW, PAN HD		CRES
69	1		2069-2018		BRACKET, CONN	C	
68	2		2069-1025		STUD, LOCATOR, HV/PS	B	
67	AR	16956	08350		FASTNER, CABLE TIE		OR EQUIV
66	AR	16956	08462		MOUNT, CABLE TIE		OR EQUIV
65	14		10-32		NUT, HEX		CRES
64	14		NO. 10		WASHER, FLAT		
63	14		NO. 10		WASHER, LOCK		
62	2		10-32X.50LG		SCREW, PAN HD		
61	10		10-32X.25LG		SCREW, PAN HD		
60	11		8-32		NUT, HEX		
59	23		NO.8		WASHER, FLAT		
58	17		NO.8		WASHER, LOCK		
57	6		8-32X.62LG		SCREW, FLAT HD		
56	6		8-32X.38LG		SCREW, PAN HD		
55	4		8-32X.19LG		SCREW, PAN HD		
54	2		8-32X.38LG		SCREW, FLAT HD, 82°		
53	10		6-32		NUT, HEX		
52	31		NO.6		WASHER, FLAT		
51	27		NO.6		WASHER, LOCK		
~~50~~	2		~~6-32X.50LG~~		~~SCREW, PAN HD~~		
49	10		6-32X.38LG		SCREW, PAN HD		
48	2		6-32X.31LG		SCREW, PAN HD		CRES
47							
46	5		6-32X.25LG		SCREW, FLAT HD, 82°		CRES
45	9		4-40		NUT, HEX		
44	8		NO.4		WASHER, FLAT		
43	16		NO.4		WASHER, LOCK		
42	2		4-40X.31LG		SCREW, PAN HD		CRES
41							
40	1	09769	640347-1		FASTON, .187 INSUL		
39	3 IN		NO. 22 AWG		WIRE, STRD, TEFLON, INSUL		BLK
38	1		2069-1110		COVER PLATE	B	
37	1PAIR	06666	C-230-S-124		SLIDE, CHASSIS		
36	1	01963	E34-90N		SWITCH, MINIATURE		S1
35	2	11873	18-S620-04-010		TERM. BLOCK, QUICK-CONNECT		TB1(DC), TB2(AC)
34	3	MIDGET LOUVRE	4"L.D., 6TAB		LOUVER		ALL ALUM
33	2		2069-1030		COVER, PANDUCT	B	
32	2		2069-1029		PANDUCT	C	
31	1	75915	303015		FUSE, 15 AMP, FAST/BLOW		F2
30	1	75915	314020		FUSE, 20 AMP, FAST/BLOW		F1
29	2	75915	342046L		FUSEHOLDER		XF1, XF2
28	1	06001	19827065P21		BRACKET, OVAL		
27	1	06001	21L3404		CAP.		C1
26	6		6-32X.50LG		SCREW, PAN HD		CRES
25	2	09769	60711-1		FASTON, .187 SOLDER		
24	1	33067	C115		FILTER, POWERLINE		FL1
23	1	78277	68R54-120C-SCO		RELAY, DPDT		K1
22	AR	83330	2694		GROMMET, "CATERPILLAR"		
21	1		2069-0002		ASSY, FRONT PANEL	E	A2
20	1		2069-2308		POWER CORD	C	
19	1		2069-2010		LGE COVER, CHASSIS	D	
18	1		2069-1007		SM COVER, CHASSIS	C	
17	REF		2069-2408		CHASSIS INTERCONNECTIONS	D	
16	1		2069-2301		WIRING HARNESS, DC	E	W2
15	1		2069-2300		WIRING HARNESS, AC	E	W1
14	1		2069-2101		ASSY, FIL-XFORMER	C	T1
13	1	60076	1509		RESISTOR, 20 Ω, 8W 5%		R1
12	1		2069-0003		ASSY, CARD CAGE	D	A3
11	1		2069-0004		ASSY, POWER SUPPLY	E	A1
10	1		2069-2103		ASSY, BLOWER	B	B1
9	1		2069-1080		SHIELD, FIL-XFORMER, RH	C	
8	1		2069-2023		SHIELD, FIL-XFORMER, LH	C	
7	1		2069-1059		FINGERS, RH	B	
6	1		2069-1058		FINGERS, LH	B	
5	2		2069-1006		SLIDE, CAVITY	C	
4	1		2069-1014		RETAINER, PLENUM GASKET	B	
3	1		2069-1015		GASKET, PLENUM	B	
2	1		2069-2022		PLENUM	D	
1	1		2069-2000		CHASSIS, MAIN	E	

PARTS LIST

*VENDOR ITEM—SEE SOURCE CONTROL OR SPECIFICATION CONTROL DRAWING

DASH NO.	NEXT ASSY	USED ON
0001		EP250C

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .XX ± .03 ANGLES ± 1°
.XXX ± .010
REMOVE ALL SHARP EDGES AND BURRS 1/64 MAX.
RELEASE
MATERIAL

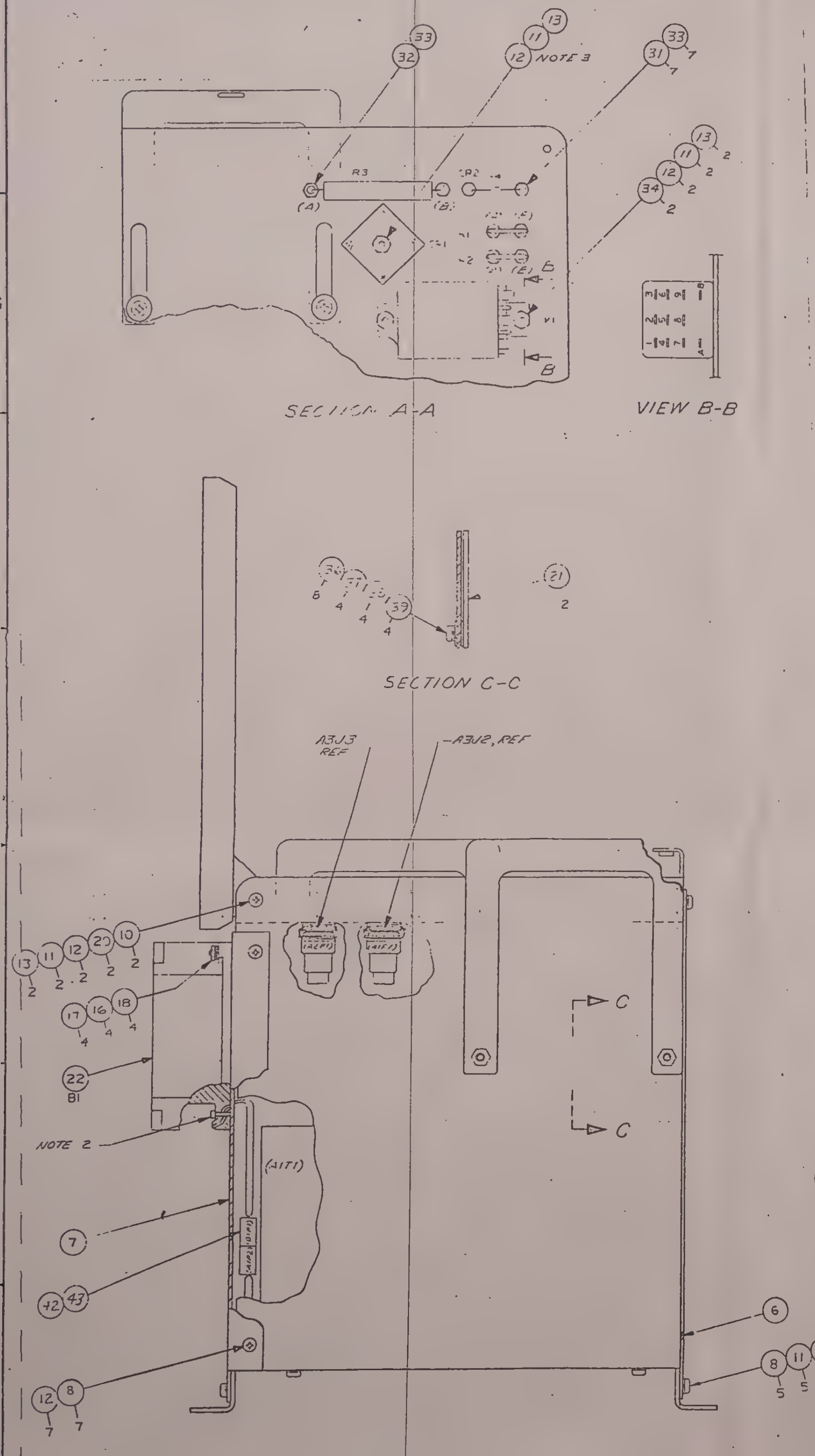
CONTRACT NO.
DRAWN D BOYER 10-16-75
CHECKED JWS 1-16-80
DESIGNER
ENGINEER
PROJECT APPROVAL

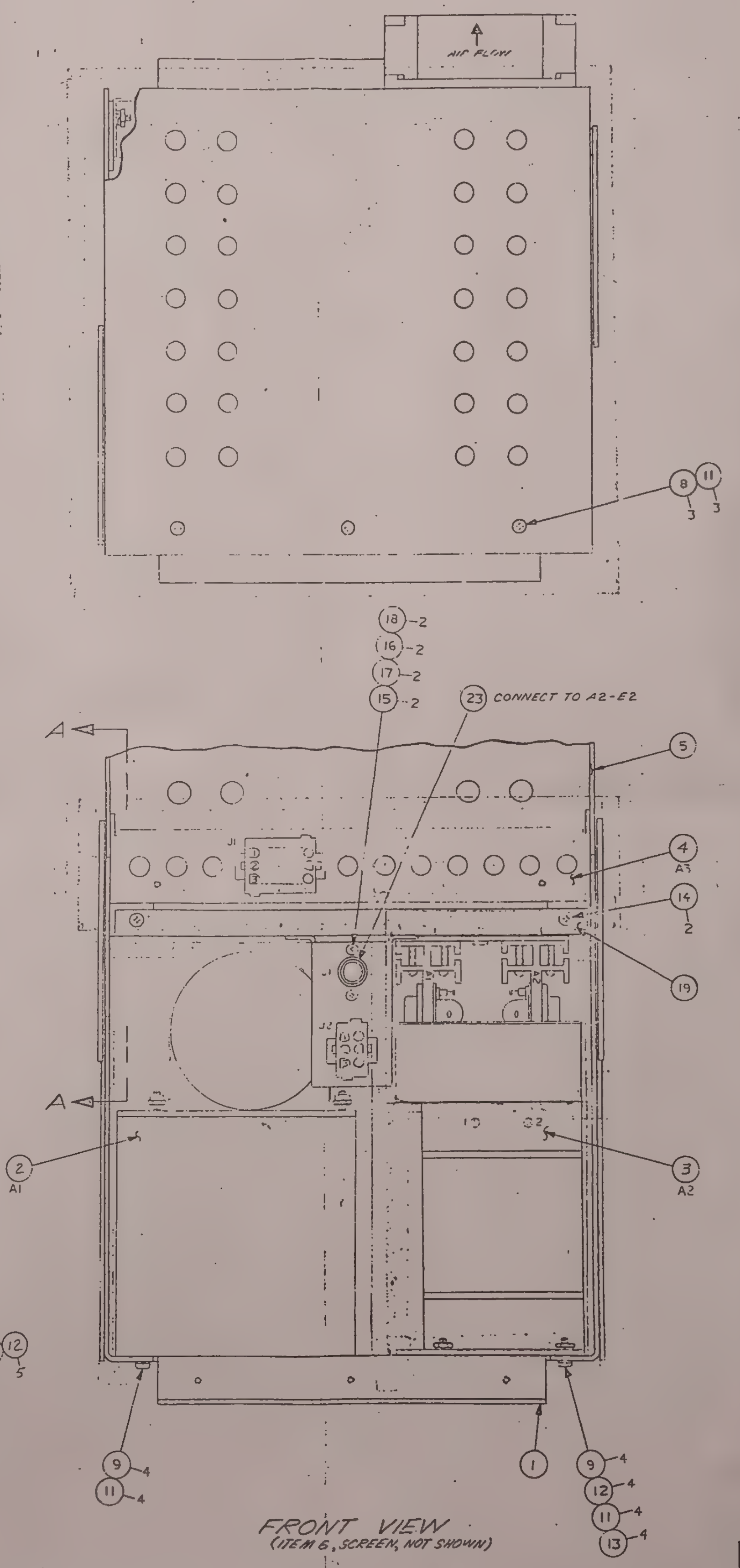
EPSCO INCORPORATED
411 PROVIDENCE HIGHWAY
WESTWOOD, MASS. 02090

ASSY,
MAIN CHASSIS,
MANUAL UNIT

SIZE E
CODE IDENT NO. 99380
2069-0001
REV B
SCALE 1/1
SHEET 1 OF 1

REVISIONS				
ZONE	LTR	DESCRIPTION	DATE	APPROVED
	A	RELEASED FOR ECO.		
	B	REVISED PER ECO LOG CC 22		J.T.





ITEM NO.	QTY REQD	CODE IDENT	PART OR IDENT NO.	SPECIFICATION NO	DESCRIPTION	DWG SIZE	MATERIAL OR NOTE
53	REF		2069-2700		SCHEMATIC DIAGRAM	—	
52	REF		2069-2410		WIRE RUN LIST	A	
51	1	56501	[illegible]		TERM, FASTON .25 [illegible]		OR EQUIV
50	2	56501	[illegible]B-187-020		TERM, FASTON .187 [illegible]		OR EQUIV
49	AR		NO. 16 AWG		WIRE, STRD, TEFLON, INSUL		[illegible]
48	↓		NO. 18 AWG		WIRE, STRD, TEFLON, INSUL		[illegible]
47			↓		↓		WHT/YEL
46							GRY
45	↓		↓		↓		GRN
44	AR		NO. 18 AWG		WIRE, STRD, TEFLON, INSUL		RED
43	2	04202	59-1016PC		CONTACT, PIN		
42	1	04202	59-02P150C		CONNECTOR, PLUG		B1P1
41	3	83330	1410-10		TERMINAL, LUG LOCKING		OR EQUIV
40	6	56501	RA-187-020		TERMINAL, FASTON .187 SERIES		OR EQUIV
39	4		NO. 8		WASHER, FLAT		CRES
38	4		NO. 8		WASHER, LOCK		CRES
37	4		6-32X.31LG		SCREW, PAN HD		CRES
36	8		2069-1103		SPACER, HANDLE/CHASSIS	B	
35	AR	05820	TYPE 120		THERMAL COMPOUND		OR EQUIV
34	2		6-32X.38LG		SCREW, FLAT HD 82°		CRES
33	8		4-40X.19LG		SCREW, FLAT HD 82°		CRES
32	1	71279	160-2180-01-05-00		TERMINAL, SOLDER		
31	7	71279	4822-1		TERMINAL, INSULATED		
30	1	78277	[illegible]		RELAY		K1
29	1		1N4001		DIODE		CR2
28	1	EDI	PW60		MINIBRIDGE		CR1
27	2	KEYSTONE	CL-10		RES, VOLT-VARIABLE, 1.6 Ω		R1, R2
26	1	[illegible]	TYPE 175-1K [illegible]		RESISTOR, 1K, 10W		R3
25							
24							
23	1		2069-2307		CABLE, HV DISCONNECT	B	J1
22	1	92702	MWS2107FL		FAN, MINI-BOXER		B1
21	2		2069-2026		HANDLE	C	
20	2	83330	8704		SPACER, NO.6		
19	1		2069-2042		MOUNT, "T"	C	
18	6		4-40		NUT, HEX		CRES
17	6		NO. 4		WASHER, FLAT		↑
16	6		NO. 4		WASHER, LOCK		
15	2		4-40X.56LG		SCREW, PAN HD		
14	2		6-32X.62LG		SCREW, FLAT HD, 82°		
13	9		6-32		NUT, HEX		
12	21		NO 6		WASHER, FLAT		
11	21		NO.6		WASHER, LOCK		
10	2		6-32X.50LG		SCREW, FLAT HD, 82°		
9	8		6-32X.44LG		SCREW, PAN HD		↓
8	15		6-32X.25LG		SCREW, PAN HD		CRES
7	1		2069-2029		SCREEN, REAR	D	
6	1		2069-2019		SCREEN, FRONT	D	
5	1		2069-2016		COVER, TOP	D	
4	1		2069-0015		ASSY, L.V. CONTROL	E	A3
3	1		2069-0018		ASSY, H.V. PWR MODULE	E	A2
2	1		2069-0017		ASSY, PRIMARY PWR MODULE	D	A1
1	1		2069-2015		CHASSIS	E	

PARTS LIST

2069-0004

NOTES

1. PARTIAL REF DES ARE SHOWN. FOR COMPLETE REF DES. PREFIX WITH UNIT NO. & THE HIGH VOLTAGE SWITCHING POWER SUPPLY ASSY REF DES: 1A1
2. SPOT TIE SELF LEADS FROM B1 TO BLOWER HOUSING APPROX AS SHOWN AND INSTALL ANY LEAD TO B1P1-1 & INSTALL OTHER LEAD TO B1P1-2.
3. APPLY THERMAL COMPOUND (ITEM 35) BETWEEN ITEM 1 AND CR1.

*VENDOR ITEM—SEE SOURCE CONTROL OR SPECIFICATION CONTROL DRAWING

DASH No	NEXT ASSY	USED ON
0004	2069-0001	EPSCO

APPLICATION

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS ANGLES
XX = ±
XXX = ±
REMOVE ALL SHARP EDGES AND BURRS
RELEASE
MATERIAL
SEE P/L

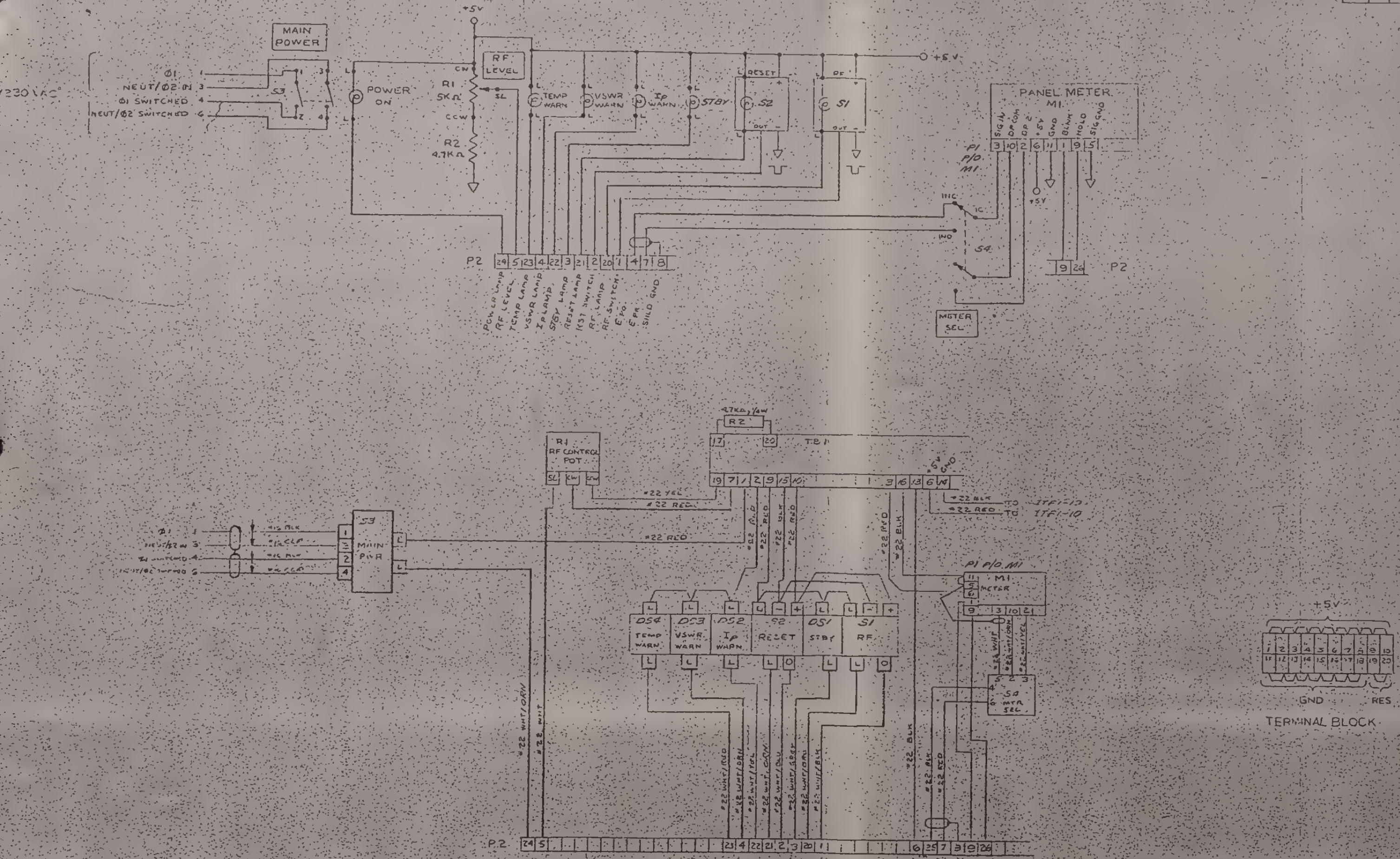
CONTRACT NO.
DRAWN D. BOYER 9-25-79
CHECKED J.W.S. 2/5/80
DESIGNER
ENGINEER
PROJECT APPROVAL 2/5/80

EPSCO INCORPORATED
411 PROVIDENCE HIGHWAY
WESTWOOD, MASS. 02090

ASSY,
POWER SUPPLY,
HIGH VOLTAGE SWITCHING

SIZE E
CODE IDENT NO. 99380
2069-0004
REV B
SCALE 1/1
SHEET 1 OF 1

SERIAL NO. AFFECTED	ZONE	LTR	DESCRIPTION	DATE	APPROVED
		A	RELEASED FOR PROD.	1/3/19	
		B	REVISED PER ECO. A1	1/31/20	JMS


MAIN POWER
230 VAC
Ø1
NEUT/Ø2 Ø1
Ø1 SWITCHED
NEUT/Ø2 SWITCHED
S3
POWER ON
+5V
RF LEVEL
R1 5KΩ
R2 4.7KΩ
CW
CCW
SL
TEMP WARN
VSWR WARN
Ip WARN
STBY
RESET
S2
RF
S1
OUT
PANEL METER M1
P1 P/O M1
SIGN
DP COM
DP 2
+5V
GND
BLANK
HOLD
SIG GND
S4
METER SEL
P2
POWER LAMP
RF LEVEL
TEMP LAMP
VSWR LAMP
Ip LAMP
STBY LAMP
RESET LAMP
RST SWITCH
RF LAMP
RF SWITCH
E PO
E PR
SHLD GND
R1 RF CONTROL POT
47KΩ, 1/4W
R2
TB1
+5V
GND
#22 YEL
#22 RED
#22 BLK
TO 1TF1-10
S3 MAIN PWR
DS4 TEMP WARN
DS3 VSWR WARN
DS2 Ip WARN
S2 RESET
DS1 STBY
S1 RF
P1 P/O M1
M1 METER
S4 MTR SEL
#22 WHT/ORN
#22 WHT
#22 WHT/RED
#22 WHT/ORN
#22 WHT/YEL
#22 WHT/GRN
#22 WHT/BLU
#22 WHT/GRAY
#22 WHT/BLK
#22 BLK
#22 RED
TO CARD CAGE
TERMINAL BLOCK
GND
RES

NOTES

1. FOR COMPLETE REF DES, PREFIX DES SHOWN WITH THE UNIT NO. & FRONT PNL ASSY (2069-0002) REF DES: 1A2

ITEM NO.	QTY REQD	CODE IDENT	PART OR IDENT NO.	SPECIFICATION NO.	DESCRIPTION	DWG SIZE	MATERIAL OR NOTE
1	REF		2069-2303		HARNESS, DC WIRING	E	W1

LIST OF MATERIAL

DIMENSIONS ARE IN INCHES AND APPLY AFTER PROCESSING
TOLERANCE UNLESS SPECIFIED
FRACTIONAL DIMENSIONS ±
DECIMAL DIMENSIONS
.XX ±
.XXX ±
ANGULAR DIMENSIONS ±

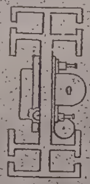
CONTR. NO.
DRAWN John M. Shalhoub DATE 2-24-19
CHECKED DATE 1/2/20
ELECT. ENGR DATE
MECH. ENGR DATE 1/11/20

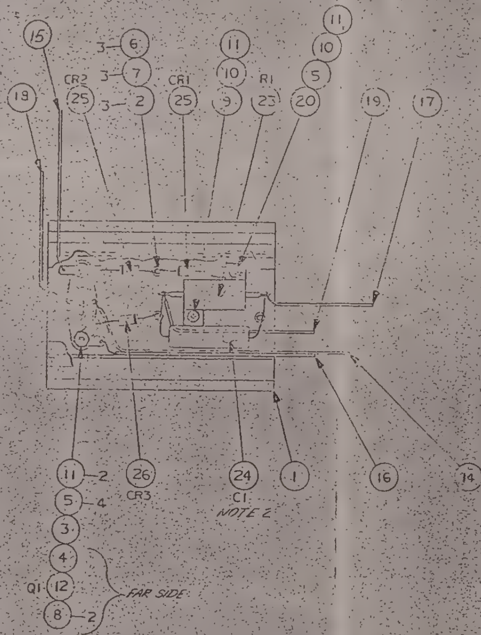
Epsco INCORPORATED
411 PROVIDENCE HIGHWAY
WESTWOOD, MASS. 02090

FRONT PANEL INTERCONNECT

2069-2400

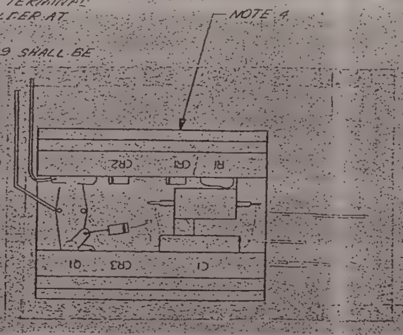
SERIAL NO. AFFECTED	ZONE	LTR	DESCRIPTION	DATE	APPROVED
—	—	2	RELEASE FOR ENGINEERING		
—	—	A	RELEASED FOR PROD.		
—	—	B	REVISED PER ECO	4/2/80	





NOTES:

1. PARTIAL REF DES. SHOWN. FOR COMPLETE REF DES. PREFIX WITH ASSY DES. A1A2A1A2.
2. WRAP THE LEADS OF CAP. 1 TURN AROUND EACH TERMINAL (ITEM 2) AND CONTINUE TO R1 AS SHOWN. SOLDER AT TERMINALS & R1.
3. THE FLYING ENDS OF WIRE ITEMS 14, 15 THRU 19 SHALL BE DRESSED AT NEXT ASSY.
4. THIS VIEW IS IDENTICAL TO THE BALLOONED VIEW WITH THE EXCEPTION OF THE REF DES BEING SHOWN.



ITEM NO.	QTY REQD	CODE IDENT	PART OR IDENT NO.	SPECIFICATION NO.	DESCRIPTION	DWG SIZE	MATERIAL OR NOTE
26	1	MOTOROLA	MR856		DIODE		CR3
25	2	TRW	TVPA-1533A		DIODE, TRANSIENT SUP, 190V ±5%		CR1, CR2
24	1	SPRAGUE	416P68396		CAP, PAPER, .068 µf, 600 V		C1
23	1		RH25XX501U		RESISTOR, 500Ω ±5%, 30W		R1
22							
21							
20	1		4-40 X .50 LG		SCREW PAN HD		CRES
19	6 IN		20 AWG		WIRE, STRD, INSUL, WHT		
18	9 IN		20 AWG		↑ ↑ ↑ YEL		
17	4 IN		20 AWG		RED		
16	7 IN		18 AWG		WHT/RED		
15	4 IN		18 AWG		↓ ↓ ↓ GY		
14	7 IN		18 AWG		WIRE, STRD, INSUL, PURP		
13	REF		2069-2701		SCHEMATIC DIAGRAM	D	
12	1	MOTOROLA	MJ10015 OR MJ10016		TRANSISTOR, DARLINGTON, NPN		Q1
11	4		NO. 4-40		NUT, HEX		CRES
10	2		NO. 4		LOCK WASH, INT TOOTH		CRES
9	1		4-40 X .44 LG		SCREW PAN HD		CRES
8	2		4-40 X .62 LG		SCREW PAN HD		CRES
7	3		NO. 2		LOCK WASH, INT TOOTH		CRES
6	3		2-56 X .31 LG		SCREW PAN HD		CRES
5	5	H.H. SMITH	1415-4		TERMINAL LUG		
4	1	BERGQUIST	7403-09FR-04		SIL-PADS		
3	1	AFE	AEM-3-HD		TRANSISTOR MOUNT		
2	3	CAMBION	4872-1		INSULATED TERMINALS		
1	1		2069-1061-P2		HEATSINK, INVERTER	C	

LIST OF MATERIAL

0013	2069-0018	EP-250C

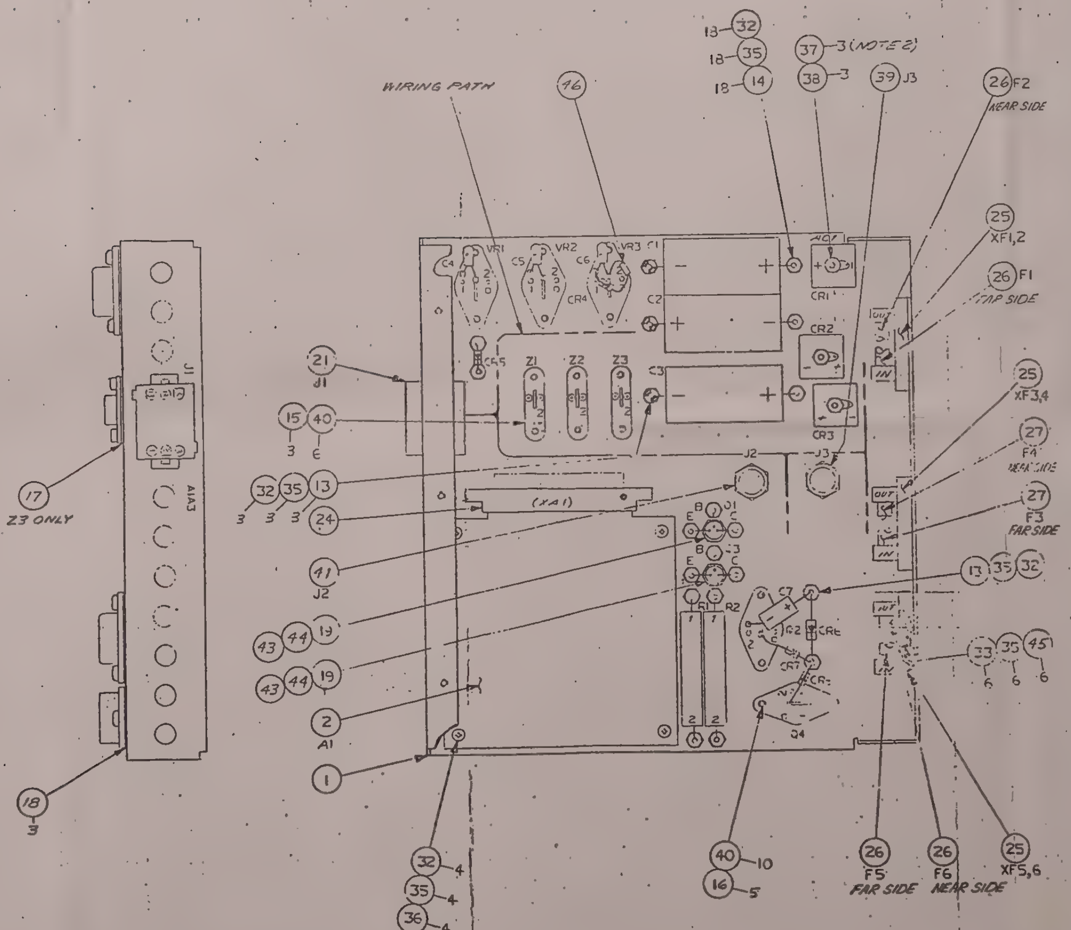
DIMENSIONS ARE IN INCHES AND APPLY AFTER PROCESSING
TOLERANCE UNLESS SPECIFIED
FRACTIONAL DIMENSIONS ± 1/64
DECIMAL DIMENSIONS
.XX ± —
.XXX ± —
ANGULAR DIMENSIONS ± 1/2°
REMOVE BURRS AND SHARP EDGES .015 RMAX.

CONTR. NO. —
DRAWN DATE 7-30-79
CHECKED RHS DATE 1-2-80
ELECT. ENGR DATE
MECH. ENGR DATE
APPROVED DATE

Epsco INCORPORATED
411 PROVIDENCE HIGHWAY
WESTWOOD, MASS. 02090

HEATSINK ASSY (RH)
H.V. POWER SUPPLY

SIZE
CODE IDENT NO.
REV


WIRING PATH
16
18-32
18-35
18-14
37-3 (NOTE 2)
38-3
39 J3
26 F2 NEAR SIDE
25 XF1,2
26 F1 FAR SIDE
25 XF3,4
27 F4 NEAR SIDE
27 F3 FAR SIDE
13 35 32
33 35 45 6 6 6
21 J1
15 40 3 6
17 Z3 ONLY
32 35 13 3 3 3
24
41 J2
43 44 19
43 44 19
2 A1
1
18 3
A1A3
J1
VR1 VR2 VR3 C4 C5 C6 CR4 C1 C2 C3 Z1 Z2 Z3 CR1 CR2 CR3 J2 J3 XA1 Q1 Q2 Q4 R1 R2 C7 C8 CR5 CR6 CR7
32-4
35-4
36-4
40-10
16-5
26 F5 FAR SIDE
26 F6 NEAR SIDE
25 XF5,6

NOTES

1. PARTIAL REF DES ARE SHOWN. FOR COMPLETE REF DES, PREFIX WITH THE ASSY REF DES: A1A3.
2. A SOLDER LUG (ITEM 37) IS TO BE PLACED AND SOLDERED ONTO EACH OF THE NEGATIVE LEADS OF CR1 & 3 AND ONTO THE POSITIVE LEAD OF CR2.

ITEM NO.	QTY REQD	CODE IDENT	PART OR IDENT NO.	SPECIFICATION NO.	DESCRIPTION	DWG SIZE	MATERIAL OR NOTE
56	AR		NO. 20 AWG		WIRE, BUSS		BRN
55	AR		NO. 20 AWG		WIRE, STRANDED, TEFLON, INSUL		BLK
54	↑		↑		↑		GRN
53							YEL
52							GRY
51							WHT/RED
50							RED
49							BLU
48	↓		↓		↓		ORN
47	AR		NO. 20 AWG		WIRE, STRANDED, TEFLON, INSUL		
46	1		TA-.1		CAP, 0.1 UF, 100V		C8
45	6		NO. 4		WASHER, FLAT (SMALL O.D.)		CRES
44	2		NO. 6		WASHER, FLAT		CRES
43	2		NO. 6		NUT, HEX		CRES
42	REF		2069-2404		WPL	A	
41	1	81312	MIDP-LRN		CONN, PC EDGE		J2
40	16	KEYSTONE	4706		SCREW, 6-20		
39	1	81312	M72-LRN		CONN, RECEPTACLE		J3
38	3		4-40		NUT, HEX		CRES
37	3	83330	1416-4		LUG, SOLDER, NO. 4		OR EQUIV
36	4		NO. 4		WASHER, FLAT		CRES
35	30		NO. 4		WASHER, LOCK		↑
34	3		4-40 X .56 LG		SCREW, PAN HD		
33	6		4-40 X .25 LG		SCREW, PAN HD		↓
32	24		4-40 X .19 LG		SCREW, PAN HD		CRES
31	1	TRW	TVP.50C		DIODE, ZENER		CR6
30	1	PANASONIC			CAP., 330 UF @ 10V		C7
29	2		1N4003		DIODE		CR7,8
28	AR	92194	FIT-221-1/8		SLEEVING, SHRINK		OR EQUIV
27	2	75915	312002		FUSE, 3AG, 2A, 250V		
26	4	75915	361001		FUSE, 8AG, 1A, 250V		
25	3	75915	357002		FUSEBLOCK, 2-POLE		XF1,2,3,4,5,6
24	1	05574	2VH15/1AN5		CONN, SOLDER		
23	2		1N4001		DIODE		CR4,5
22	14	09769	350689-1		CONTACT, SOCKET		
21	1	09769	1-480711-0		CONN, UNIV, 15FOS		J1
20	3	ITT	TAG		CAP., 10UF @ 35V		C4,5,6
19	2	05820	260-6SHSE		CLIP-CLAMP, SERIES 260		XQ1,3
18	3	BERQUIST CO.	7403-09FR-04		SIL-PAD, TO-3		XQ2,4 & VR3
17	1	BERQUIST CO.	3223-07FR-10		SIL-PAD, TO-66		XZ3
16	5	KEYSTONE	4602		MOUNT, TRANSISTOR		XQ2,4 XVR1,2,3
15	3	KEYSTONE	4612		MOUNT, TRANSISTOR		XZ1,2,3
14	16	71279	572-4626-01-05-16		TERM., INSUL		
13	4	71279	160-2330-01-05-00		TERM., SOLDER		
12	2	RCD COMP.	TYPE 175X-.15Ω ±5%		RES, WW, .15Ω, 10W, N.I.		R1,2
11	2	MOTOROLA	MJ10005		TRANSISTOR, DARLINGTON, NPN		Q2,4
10	2		2N4036		TRANSISTOR, PNP		Q1,3
9	1	80103	L20V12		OVERVOLTAGE		Z2
8	2	80103	L20V5		OVERVOLTAGE		Z1,3
7	3	EDI	PB-F 50V		BRIDGE RECT, 50V, 8A		CR1,2,3
6	3	PANASONIC	ECEB1EV472S		CAP., 4700UF, 25V		C1,2,3
5	1	80103	LAS1805		REG, VOLT., -5V		VR3
4	1	80103	LAS1512		REG, VOLT., +12V		VR2
3	1	80103	LAS1505		REG, VOLT., +5V		VR1
2	1		2069-0020		ASSY, HV CONTROL P/W	D	A1
1	1		2069-2017		CHASSIS, LV CONTROL	D	

PARTS LIST

DASH NO.	NEXT ASSY	USED ON
0015	2069-0004	EF250C

APPLICATION

*VENDOR ITEM—SEE SOURCE CONTROL OR SPECIFICATION CONTROL DRAWING

UNLESS OTHERWISE SPECIFIED
DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS XX = .02 ANGLES ±1°
XXX = .005
REMOVE ALL SHARP EDGES AND BURRS 1/64 MAX.

RELEASE

MATERIAL
SEE P/L

CONTRACT NO.

DRAWN DECKER 4-29-79
CHECKED JHS 2-5-80
DESIGNER
ENGINEER 2/1/80
PROJECT APPROVAL 2/5/80

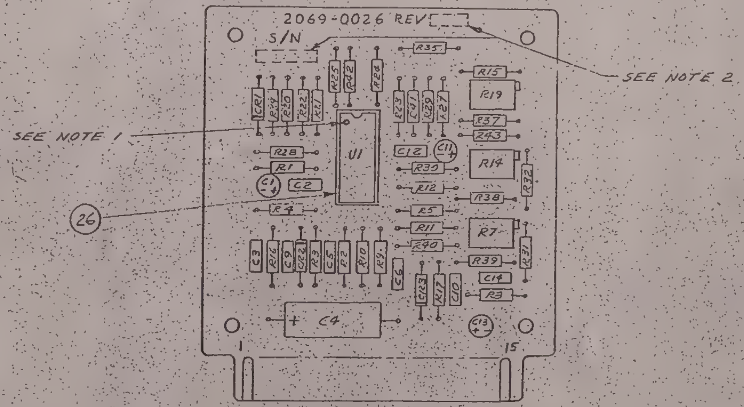
EPSCO INCORPORATED
411 PROVIDENCE HIGHWAY
WESTWOOD, MASS. 02090

ASSY, LV CONTROL, HV PS

SIZE E | CODE IDENT NO. 99380 | 2069-0015 | B

SCALE 1/1 | SHEET 1 OF 1

SERIAL NO. AFFECTED	REVISIONS				
	ZONE	LTR	DESCRIPTION	DATE	APPROVED
—	—	1	RELEASED FOR PRODUCTION		
	–	A	REWORK INST. FOR S/N 001 THRU 015 ONLY SEE ECO 1/-1 DWG REVISED PER ECO 1/-2	1/20/81	


2069-0026 REV
S/N
SEE NOTE 2
SEE NOTE 1
26
R35
R15
R19
R25
R42
R24
CR1
R44
R20
R22
R21
R23
C41
R29
R27
R37
R43
U1
R28
R1
C1
C2
C12
C11
R14
R30
R12
R32
R38
R4
R5
R11
R7
R40
R39
R31
C3
R16
C9
CR2
R3
C5
R2
R10
R9
C6
CR3
R17
C10
C14
R8
C4
C13
1
15

NOTES:
1. DOT INDICATES PIN 1 OF COMPONENT.
2. MARK SERIAL NO. AND ASSY REV. LETTER .12 HIGH IN CONTRASTING COLOR WITH PERMANENT INK.
3. RESISTANCE VALUE OF R28 & R41 MAY BE CHANGED AT TEST.

ITEM NO.	QTY. REQD	CODE IDENT	PART OR IDENT NO.	SPECIFICATION NO.	DESCRIPTION	DWG SIZE	MATERIAL OR NOTE
30							
29							
28							
27	3		1N914		DIODE		CR1,2,3
26	1	ARIES	14-512-10		DIP SOCKET (14 PIN)		XU1
25	1	BOURNS	3299X-1-203		RES., VAR. 20K		R19
24	2	BOURNS	3299X-1-201		RES., VAR. 200Ω		R7,14
23							
22							
21	1		RN55D9091F	COMMERCIAL	RES, 9.09K, ±1%, 1/10W		R35
20	1		RN55D1502F		15.0K		R11
19	1		RN55D1271F		1.27K		R9
18	2		RN55D1101F		1.1K		R5,12
17	1		RN55D7502F		75.0K		R4
16	1		RN55D1241F		RES., 1.24K, ±1%, 1/10W		R2
15	2		RC07GF104J		RES., 100K, ±5%, 1/4W		R42,43
14	4		RC07GF510J		RES., 51Ω, ±5%, 1/4W		R37,38,39,40
13	4		RC07GF512J		5.1K		R8,15,31,32
12	2		RC07GF121J		120Ω		R22,29
11	2		RC07GF186J		18M		R21,23
10	6		RC07GF103J		10K		R20,24,25,27,28,41
9	5		RC07GF102J		1K		R3,10,16,17,34
8	2		RC07GF101J	COMMERCIAL	RES., 100Ω, ±5%, 1/4W		R1,30
7	2						
6	1	NICHICON	16ELA47		CAP., 47µF @16V		C4
5	8	ARCO	4MCG-C-474M		CAP., .47µF @ 100V		C2,3,5,6,9,10,12,14
4	3	ITT	TAG20-10/35-50/20		CAP., 10µF @35V		C1,11,13
3	1		LM324		INT. CKT. (14 PIN DIP)		U1
2	REF		2069-2726		LOGIC DIAGRAM	C	
1	1		2069-1026		P/W BOARD	C	

LIST OF MATERIAL

DOCUMENT CONTROL
NOV 19 1980

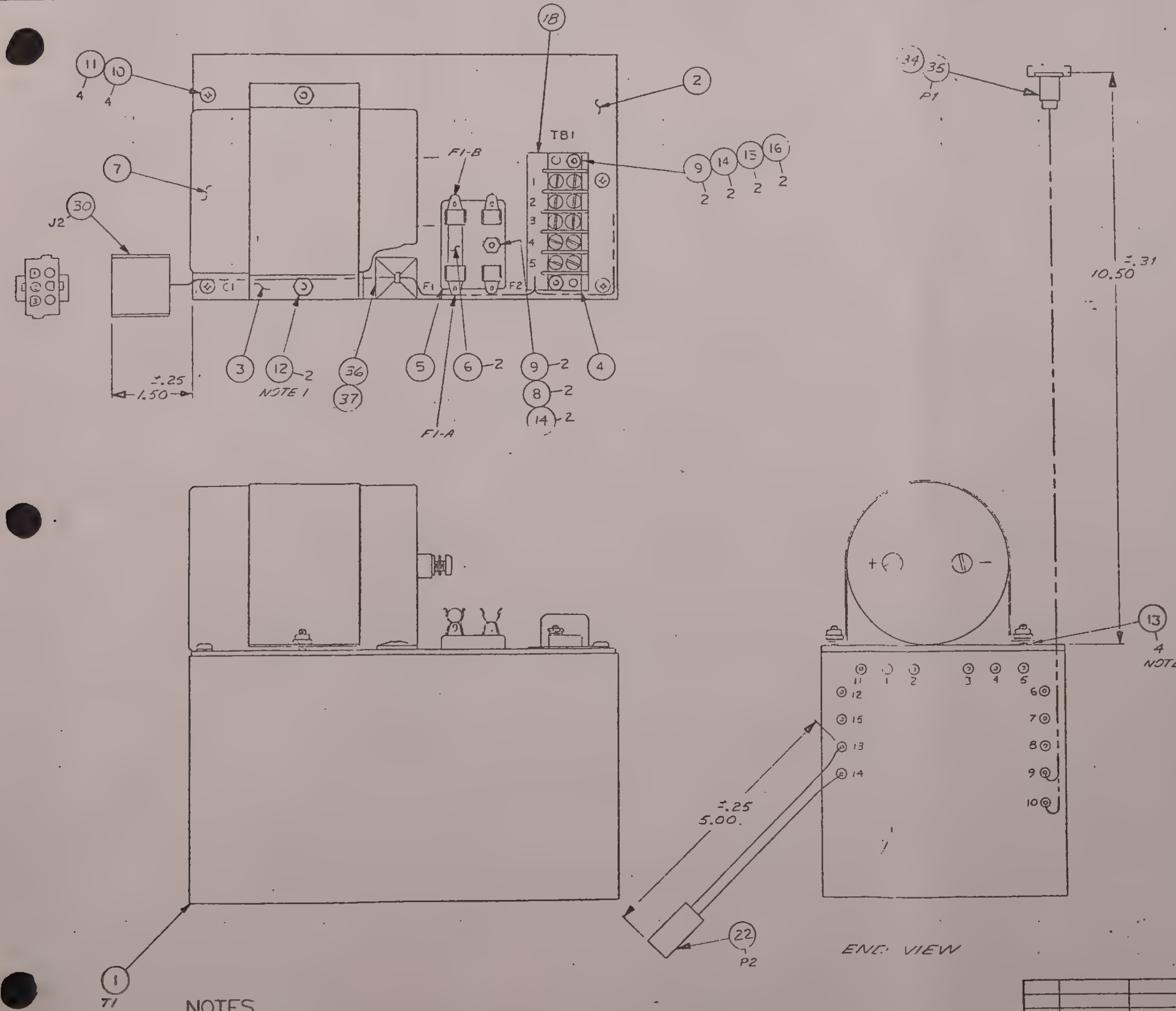
DIMENSIONS ARE IN INCHES AND APPLY AFTER PROCESSING
TOLERANCE UNLESS SPECIFIED
FRACTIONAL DIMENSIONS ± 1/64
DECIMAL DIMENSIONS
.XX ±
.XXX ±
ANGULAR DIMENSIONS ± 1/2°

CONTR. NO.
DRAWN V.N. DENIETOLIS DATE 11/12/79
CHECKED DATE
ELECT. ENGR. DATE
MECH. ENGR DATE 5/2/

Epsco INCORPORATED
411 PROVIDENCE HIGHWAY
WESTWOOD, MASS. 02090

PRINTED WIRING ASSEMBLY
PWR METER AMP &
HIGH VSWR DET

SERIAL NO. AFFECTED	ZONE	LTR	DESCRIPTION	DATE	APPROVED
		A	RELEASED FOR PROD.	1/17/80	
		B	REVISED PER ECO LCS CK-22	8/28/80	



ITEM NO.	QTY REQD	CODE IDENT	PART OR IDENT NO.	SPECIFICATION NO.	DESCRIPTION	DWG SIZE	MATERIAL OR NOTE
37	1	16956	08474		CABLE TIE		OR EQUIV
36	1	16956	08461		CABLE TIE MOUNT		OR EQUIV
35	1	81312	MOS-6SH19		CONNECTOR, RECEPTACLE		P1
34	AR	32194	FIT-221-1/8		SLEEVING, SHRINK		OR EQUIV
33	AR		NO. 20 AWG		WIRE, STRD, TEFLON, INSUL		GRY
32	AR		NO. 20 AWG		WIRE, STRD, TEFLON, INSUL		YEL
31	4	09769	3050707-1		CONTACT, PIN		
30	1	09769	1-480705-0		CONN, UNIV 6 POS		J2
29	AR		NO. 18 AWG		WIRE, STRD, TEFLON, INSUL		WHT
28	↑		NO. 18 AWG		↑		BLK
27			NO. 20 AWG				ORN
26			NO. 20 AWG				BLU
25	↓		NO. 20 AWG		↓		RED
24	AR		NO. 20 AWG		WIRE, STRD, TEFLON, INSUL		BLK
23	2	81312	159-101850		CONTACT, SOCKET		
22	1	81312	59-0251000		CONN. FEMALE		P2
21	1	83330	1410-10		TERM LUG, LOCKING		OR EQUIV
20	6	56501	RA-333		TERM LUG, INSUL		OR EQUIV
19	1	56501	RA-157-020		TERM, FASTON .187 SERIES		OR EQUIV
18	1	10651	MF-76005-103		STRIP, MARKER		
17	REF		2069-2402		WRL, PRIMARY PWR MODULE	A	
16	2		4-40 X .56 LG		SCREW, FLAT		CRES
15	2		NO. 4		WASHER, FLAT		↑
14	2		NO. 4		WASHER, LOCK		↓
13	4		NO. 5		WASHER, FLAT		CRES
12	2	72962	73NM-62		NUT, HEX		
11	4		NO. 6		WASHER, LOCK		CRES
10	4		6-32 X .31 LG		SCREW, PAN HD		↑
9	4		4-40		NUT, HEX		↓
8	2		4-40 X .38 LG		SCREW, PAN HD		CRES
7	1	80031	86F1956HA		CAP., 5000UF, 200VDC		C1
6	1	75915	312010		FUSE, 3AG, 10AMP		F1
5	1	75915	350330		FUSE BLOCK		XF1, XF2
4	1	10651	76005		TERMINAL STRIP		TB1
3	1		2069-1056		STRAP, CAP.	C	
2	1		2069-2024		MTG PLATE, ISOLATION COMP	C	
1	1		2069-3006		XFORMER, ISOLATION	D	T1

LIST OF MATERIAL

DIMENSIONS ARE IN INCHES AND APPLY AFTER PROCESSING
TOLERANCE UNLESS SPECIFIED
FRACTIONAL DIMENSIONS ±
DECIMAL DIMENSIONS
.XX ± .
.XXX ± .
ANGULAR DIMENSIONS ±

CONTR. NO.
DRAWN D BOYER DATE 8-21-79
CHECKED DATE 1-17-80
ELECT. ENGR DATE
MECH ENGR DATE
APPROVED DATE

Epsco INCORPORATED
411 PROVIDENCE HIGHWAY
WESTWOOD, MASS. 02090

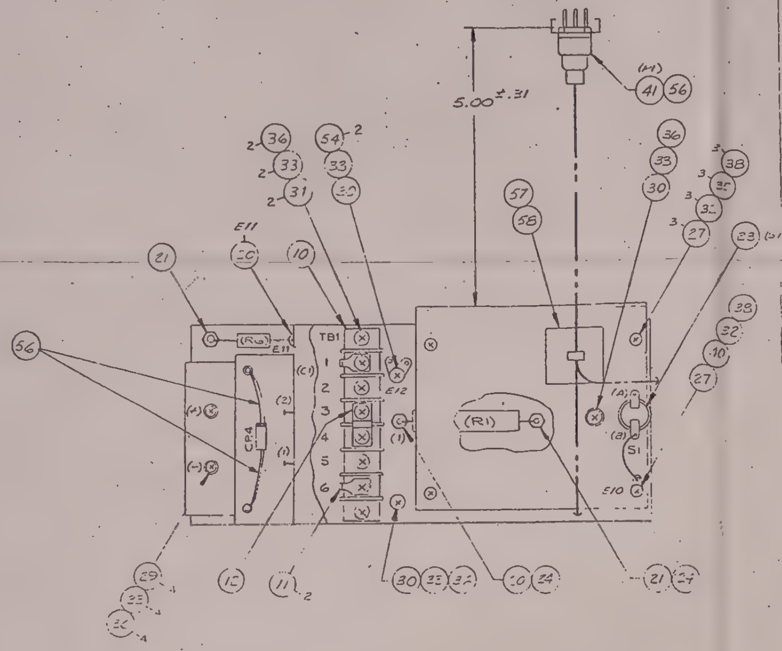
ASSY, PRIMARY PWR MODULE,
HV/PS

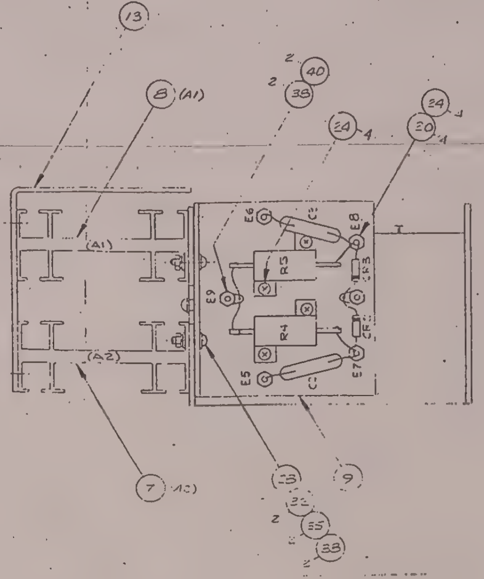
SIZE | CODE IDENT NO. | REV

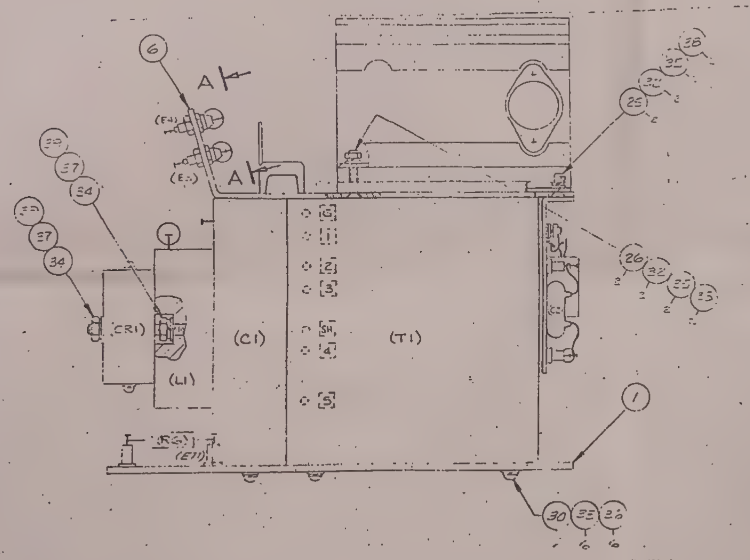
NOTES

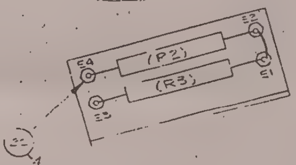
1. DO NOT OVER BEND THE FEET OF THE STRAP (ITEM 3) WHEN FASTENING THEM WITH THE NUTS (ITEM 12). INSTALL AN EQUAL NUMBER OF FLAT WASHERS (ITEM 13) UNDER EACH FOOT TO PREVENT OVER BENDING WHEN IT APPEARS NECESSARY.

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	B	REVISED & REDRAWN PER ECO LOG #CR-22	[illegible]	[illegible]









VIEW A-A

ITEM NO.	QTY REQD	CODE IDENT	PART OR IDENT NO.	SPECIFICATION NO.	DESCRIPTION	DWG SIZE	MATERIAL OR NOTE
59	REF		[illegible]		WIRE RUN LIST	A	
58	1	16956	CB474		CABLE TIE		OR EQUIV
57	1	16956	CB462		CABLE TIE MOUNT		OR EQUIV
56	AR	32194	FIT-221-1/8		SLEEVING, SHRINK		OR EQUIV
55	1	83330	1415-10		TERM LUG, LOCKING		
54	2	83330	1415-6		TERM LUG, LOCKING		
53	AR	32194	FIT-221-1/4		SLEEVING, SHRINK		OR EQUIV
52	AR		NO. 22 AWG		WIRE, BUSS		
51	↑	ITT	SEHV(30)-1930(10)		WIRE, HIGH VOLTAGE		
50			NO. 20 AWG		WIRE, STRD, TEFLON, INSUL		WHT/RED
49			NO. 18 AWG		↑		RED
48			NO. 18 AWG				VIO
47			NO. 18 AWG				BLK
46			NO. 22 AWG				BRN
45	↓		NO. 22 AWG		↓		GRY
44	AR		NO. 22 AWG		WIRE, STRD, TEFLON, INSUL		YEL
43	1	[illegible]	[illegible]		[illegible] FASTON [illegible]		
42	17	[illegible]	[illegible]		TERM LUG [illegible]		
41	1	[illegible]	[illegible] 19		CONN 7 PIN/PLUG		P1
40	3	83330	1415-4		TERM LUG - LOCKING		
39	2		10-32		NUT HEX		CRES
38	12		4-40		NUT HEX		↑
37	2		NO. 10		WASHER, LOCK		
36	14		NO. 6		WASHER, LOCK		
35	9		NO. 4		WASHER, LOCK		
34	2		NO. 10		WASHER, FLAT		
33	15		NO. 6		WASHER, FLAT		
32	9		NO. 4		WASHER, FLAT		
31	2		6-32 x .50LG		SCREW, PAN HD		
30	9		6-32 x .25LG		SCREW, PAN HD		
29	4		6-32 x [illegible]		SCREW PAN HD		
28	2		4-40 x .38LG		SCREW, PAN HD		
27	4		4-40 x .31LG		SCREW, PAN HD		
26	2		4-40 x .56LG		SCREW, FLAT HD 82°		
25	2		4-40 x .31LG		SCREW, FLAT HD 82°		↓
24	10		4-40 x .19LG		SCREW, FLAT HD 82°		CRES
23	1	ELMWOOD SENSORS	3450NO.-75°C		THERMOSTAT		S1
22	4	71279	570-[illegible]		TERM TURRET THD MT		
21	2	71279	160-[illegible]		TERMINAL, SOLDER		
20	6	71279	572-4626-01-05-[illegible]		TERMINAL INSULATED		
19	5	MOTOROLA	M2556		DIODE		[illegible]
18	2	56289	115P[illegible]		CAP, .0022 µF 5500V		C2, C3
17	1	RCD COMP	TYPE 110-2 [illegible] 5%		RESISTOR [illegible] 7W		R6
16	2	RCD	TYPE 615		RES, 25 Ω 25W, 5%		R4, R5
15	2	KDI PYROFILM	PVC175-2.2M 5%		RES, H.V. 2.2MΩ, [illegible]		R2, R3
14	1	RCD COMPONENTS	TYPE 175-0 12.5%		RESISTOR H.V., [illegible] 10%		R1
13	1		2069-2025		TOP PLATE, INSULATOR	C	
12	1	13150	8131		JUMPER, TERM BD		
11	2	13150	[illegible]		TERM, SOLDER, FEED THRU		
10	1	13150	13106		TERM STRIP		TB1
9	1		2069-3042		MTG ANGLE, COMP	C	
8	1		2069-0014		HEAT SINK ASSY (LH)	D	A1
7	1		2069-0013		HEAT SINK ASSY (RH)	D	A2
6	1		2069-1054		HEAT SINK PLATE	C	
5	1	EDI	ED6080		SINGLE PHASE FWD ASSY		CR1
4	1		2069-3003		CHOKE, HV	D	L1
3	1		2069-3002		CAPACITOR, HV	D	C1
2	1		2069-3001		TRANSFORMER HV	D	T1
1	1		2069-2025		MTG PLATE	D	

LIST OF MATERIAL

DASH NO.	NEXT ASSY	USED ON
0018	2069-0016	EP-505

APPLICATION

DIMENSIONS ARE IN INCHES AND APPLY AFTER PROCESSING
TOLERANCE UNLESS SPECIFIED
FRACTIONAL DIMENSIONS ±
~~DECIMAL DIMENSIONS~~
.XX ±
.XXX ±
ANGULAR DIMENSIONS ±
REMOVE BURRS AND SHARP EDGES .015 RMAX.
MATERIAL

CONTR. NO.
DRAWN D ZOVER DATE 9-7-79
CHECKED DATE -19-80
ELECT. ENGR DATE
MECH. ENGR DATE
APPROVED DATE
APPROVED DATE

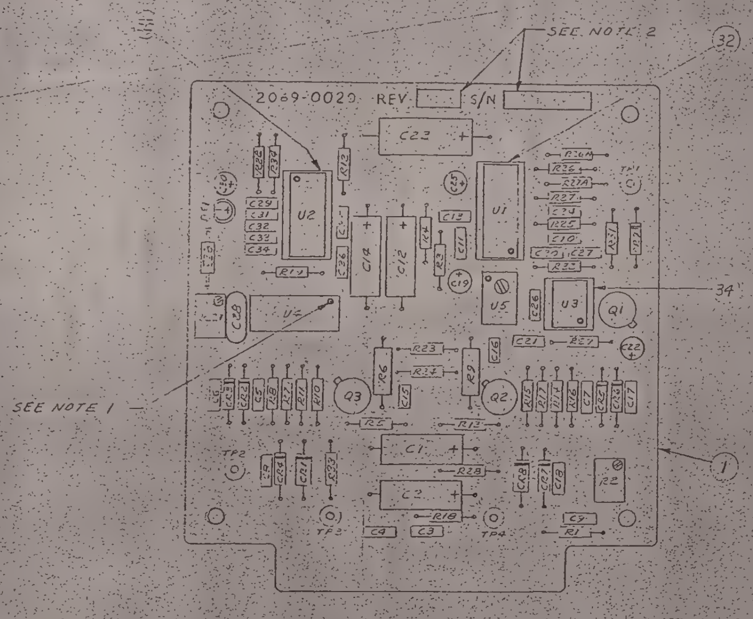
Epsco INCORPORATED
411 PROVIDENCE HIGHWAY
WESTWOOD, MASS. 02090

ASSY, HV PWR MODULE
HV/PS

SIZE E | CODE IDENT NO. 99380 | 2069-0018 | REV B
SCALE 1/1 | WT CALC | ACT | SHEET 1 OF 1

8 7 6 5 4 3 2 1

SERIAL NO. AFFECTED	ZONE	LTR	DESCRIPTION	DATE	APPROVED
—	—	A	RELEASED FOR PRODUCTION		



NOTES:

1. DOT INDICATES PIN 1 OF COMPONENT.
2. MARK SERIAL NO. & ASSY. REV. LETTER .12 HIGH IN CONTRASTING COLOR WITH PERMANENT INK.
3. SOLDER ALL COMPONENTS USING ITEM 41.
4. ALL ICS TO BE INDUSTRIAL GRADE (0°–70°C AND OR BETTER) DUAL-IN-LINE (DIP) TYPE TO BE PLASTIC CASE (CERAMIC CASE IS AN ACCEPTABLE ALTERNATE).
5. RESISTORS R26A, R27A & R32 TO BE SELECTED AT TEST. APPROX VALUE FOR R32 IS 3K.

SEE NOTE 5 { 43, 42

ITEM NO.	QTY REQD	CODE IDENT	PART OR IDENT NO.	SPECIFICATION NO.	DESCRIPTION	DWG SIZE	MATERIAL OR NOTE
43	2		RC07		RES. ___ ±5%, 1/4W		R26A, 27A
42	1		RC07		RES. 3K, ±5%, 1/4W		R32
41	AR		SN60		SOLDER		
40	4	[illegible]	105-0857-001		VERTICAL JACK		TP1-4
39	1	BOURNS	7106-138-103		INT. RES. NET (8 PIN DIP)		U5
38	1	BECKMAN	899-3-R10K		RES. NET. (14 PIN DIP)		U4
37	1		555		INT. CKT. (8 PIN DIP)		U3
36	1		3302		INT. CKT. (14 PIN DIP)		U2
35	1		3525		INT. CKT. (16 PIN DIP)		U1
34	1	ARIES	8-512-10		SOCKET, 8 PIN DIP		
33	1	ARIES	14-512-10		SOCKET, 14 PIN DIP		
32	1	ARIES	16-512-10		SOCKET, 16 PIN DIP		
31	1	BOURNS	3299W-1-102		RES., VAR., 1K		R21
30	1	BOURNS	3299W-1-203		VAR., 20K		R2
29	1		RN55	COM	2.7K, ±1%, 1/8W		R27
28	1		RN55		150Ω, ±1%, 1/8W		R26
27	2		RC20		240Ω, ±5%, 1/2W		R6, 9
26	1		RC07		1K, ±5%, 1/4W		R31
25	2				100Ω		R28, 34
24	1				15K		R25
23	2				100K		R23, 24
22	1				5.1K		R19
21	2				4.7K		R12, 20
20	4				330Ω		R8, 11, 16, 17
19	8				510Ω		R5, 7, 10, 13, 14, 15, 18, 33
18	2				10Ω		R3, 4
17	3		RC07	COM	RES., 2K, ±5%, 1/4W		R1, 22, 29
16	3		2N2222		TRANSISTOR		Q1, 2, 3
15	1	[illegible]	[illegible]		LED, CLEAR		DS1
14	2		1N5236		DIODE		CR4, 7
13	5		1N914		DIODE		CR2, 3, 5, 6, 9
12	2		1N5062		DIODE		CR1, 8
11	1	ARCO	ADM15-561J		CAP., 560pf, ±5%		C28
10	1	ITT	TAG-1.0/35		1μF @ 35V		C25
9	1	FRAKO	KEI/100/40		100μF @ 40V		C23
8	3	ITT	TAG-10/35		10μF @ 35V		C19, 22, 20
7	2		CK05BX102K		.001μF, ±10%, 200V		C15, 16
6	4		CK06BX104K		.1μF, ±10%, 100V		C6, 8, 17, 18
5	2		CK06BX224K		.22μF, ±10%, 50V		C5, 7
4	18		CK06BX103K		.01μF, ±10%, 200V		C3, 4, 9, 10, 11, 13, 20, 21, 22, 27, 29, 31–36
3	4	NICHICON	16ELA4.7		CAP., 47μF @ 16V		C1, 2, 12, 14
2	REF		2069-2700		SCHEM. DIAGRAM	E	
1	1		2069-1020		P/W BOARD	D	

LIST OF MATERIAL

DIMENSIONS ARE IN INCHES AND APPLY AFTER PROCESSING
TOLERANCE UNLESS SPECIFIED
FRACTIONAL DIMENSIONS ± 1/64
DECIMAL DIMENSIONS
.XX ±
.XXX ±
ANGULAR DIMENSIONS ± 1/2°
REMOVE BURRS AND SHARP EDGES

CONTR. NO.
DRAWN J. N. DENIKITOLIS DATE 9/12/77
CHECKED DATE 9/11/
ELECT. ENGR DATE
MECH. ENGR DATE
APPROVED DATE

Epsco INCORPORATED
411 PROVIDENCE HIGHWAY
WESTWOOD, MASS. 02090

PRINTED WIRING ASSEMBLY
H.V. CONTROL BD.

SIZE D
CODE IDENT NO.

0020 EP250C

—	—	2	UPDATED DWG. & LIST		
—	—	A	RELEASED FOR PRODUCTION	[illegible]	[illegible]

DOT INDICATES PIN 1 OF COMPONENT.

MARK SERIAL NO & ASSY. REV. LETTER .12 HIGH IN CONTRASTING COLOR WITH PERMANENT INK.

SOLDER ALL COMPONENTS USING ITEM 56.

ALL IC'S TO BE INDUSTRIAL GRADE (0°-70°C MIN. OR BETTER) DUAL-IN-LINE (DIP) TYPE TO BE PLASTIC CASE (CERAMIC CASE IS AN ACCEPTABLE ALTERNATE).

RESISTANCE VALUES FOR R22, R25 & R29 MAY BE CHANGED AT TEST.

ITEM NO	QTY REQD	CODE IDENT	PART OR IDENT NO.	SPECIFICATION NO	DESCRIPTION	DWG SIZE	MATERIAL OR NOTE
64	AR		*22		SLEEVING INSUL.		
63	1		RC07GF243J	COMMERCIAL	RES., 24K, ±5%, 1/4W		R[illegible]
62	1		RC07GF222J	↕	2.2K		R[illegible]
61	1		RC07GF822J	↕	8.2K		[illegible]
60	1		RC07GF121J	COMMERCIAL	RES, 120Ω, ±5%, 1/4W		R39
59	AR		*22 AWG		WIRE, SOLID, BUSS		
58	10	ARIES	16-512-10		SOCKET (16 PIN DIP)		[illegible]
57	11	ARIES	14-512-10		SOCKET (14 PIN DIP)		OR EQUIV.
56	AR		SN60		SOLDER		
55	1	DIALCO	551-0505		LED		DS1
54	2		RC07GF202J	COMMERCIAL	RES., 2K ±5%, 1/4W		R43,44
53	2		2N2222		TRANSISTOR		Q1,2
52							
51	1		RC07GF113J	COMMERCIAL	RES, 11K ±5%, 1/4W		R38
50	1		RC07GF203J		20K		R37
49	2		RC07GF153J		15K		R35,40
48	1		RC07GF103J		10K		R34
47	1		RC07GF225J		2.2M		R33
46	2		RC07GF241J		240Ω		R31,32
45	2		RC07GF106J		10M		R28,30
44	2		RC07GF101J		100Ω		R27,42
43	1		RC07GF180J		18Ω		R23
42	2		RC07GF102J		1K		R21,36
41	1		RC07GF473J	COMMERCIAL	RES, 47K, ±5%, 1/4W		R20

LIST OF MATERIAL

ITEM NO	QTY REQD	CODE IDENT	PART OR IDENT NO	SPECIFICATION NO	DESCRIPTION	DWG SIZE	MATERIAL OR NOTE
40	1		RC07GF912J	COMMERCIAL	RES, 9.1K, ±5% 1/4W		R[illegible]
39	1		RC07GF753J	↕	RES, 75K, ±5%, 1/4W		R17
38	4		RC07GF512J	↕	RES, 5.1K ±5% 1/4W		R15,16,19,[illegible]
37	1		RN55D1001F	↕	RES, 1K, ±1%, 1/4W		R13
36	8		RC07GF201J	COMMERCIAL	RES, 200Ω, ±5%, 1/4W		R5-12
35	2	BOURNS	3299X-1-502		RES, VAR, 5K		R3,4
34	1	BOURNS	3299X-1-203		RES, VAR, 20K		R2
33	1	BOURNS	3299X-1-102		RES, VAR, 1K		R1
32	2		1N914		DIODE		CR4,5
31	3		1N4001		DIODE		CR1-3
30	3	ITT	TAG20-100/20 5% [illegible]		CAP, 100µF @ 20V		C[illegible],37,[illegible]
29	1	ITT	TAG20-22/16 5% [illegible]		CAP, 22µF @ 16V		C[illegible]
28	7	ITT	TAG20-10/35 [illegible]		CAP, 10µF @ 35V		C[illegible]-C34
27							
26	28	ARCO	4N[illegible]-C-474M		CAP .47µF @ 100V		C1-C27,39
25	1	[illegible]	[illegible]X0015DA		CAP, ASSY (16 PIN DIP)		U30
24	1	BECKMAN	[illegible]-3-R10K		RES. NET (16 PIN DIP)		U3
23	2	SPRAGUE	[illegible]X0PD		CAP NET (8 PIN SIP)		U28,29
22	2	BECKMAN	764-1-R1K		RES. NET (8 PIN SIP)		U26,27
21	1		7421		INT. CKT. (14 PIN DIP)		U25
20	1		7475		↑ 16 PIN DIP)		U24
19	1		7402		14 PIN DIP		U23
18	1		7404		(14 PIN DIP)		U22
17	1		7432		14 PIN DIP)		U21
16	1		7427		14 PIN DIP)		U20
15							
14	1		7411		(14 PIN DIP)		U16
13							
12	1		9602		(16 PIN DIP)		U12
11	1		7400		(14 PIN DIP)		U11
10	4		7545C		8 PIN DIP)		U9,15,17,18
9	1		556		(14 PIN DIP)		U7
8	2		7474		(14 PIN DIP)		U6,8
7	1		LM393		(8 PIN DIP)		U5
6	1		IH5018		↓ (8 PIN DIP)		U4
5	1		LM324		INT. CKT. (14 PIN DIP)		U2
4	1	MINELCO	SW40-1142		SWITCH (16 PIN DIP)		U1
3	1	ARIES	16-[illegible]3-[illegible]		SOCKET, HORIZ. M[illegible]		
2	REF		2069-3323		LOGIC DIAGRAM	D	
1	1		2069-1023		P/W BOARD	D	[illegible]

LIST OF MATERIAL

0023	2069	E?250C
DASH NO.	NEXT ASSY	USED ON

APPLICATION

DIMENSIONS ARE IN INCHES AND APPLY AFTER PROCESSING

TOLERANCE UNLESS SPECIFIED

FRACTIONAL DIMENSIONS ± 1/64

DECIMAL DIMENSIONS

.XX ±

.XXX ±

ANGULAR DIMENSIONS ± 1/2°

REMOVE BURRS AND SHARP EDGES .015 RMAX

MATERIAL —

CONTR NO

DRAWN V. M. NIETSCH DATE 10/10/79

CHECKED [illegible] DATE [illegible]

ELECT ENGR DATE

MECH ENGR DATE

APPROVED DATE

APPROVED DATE

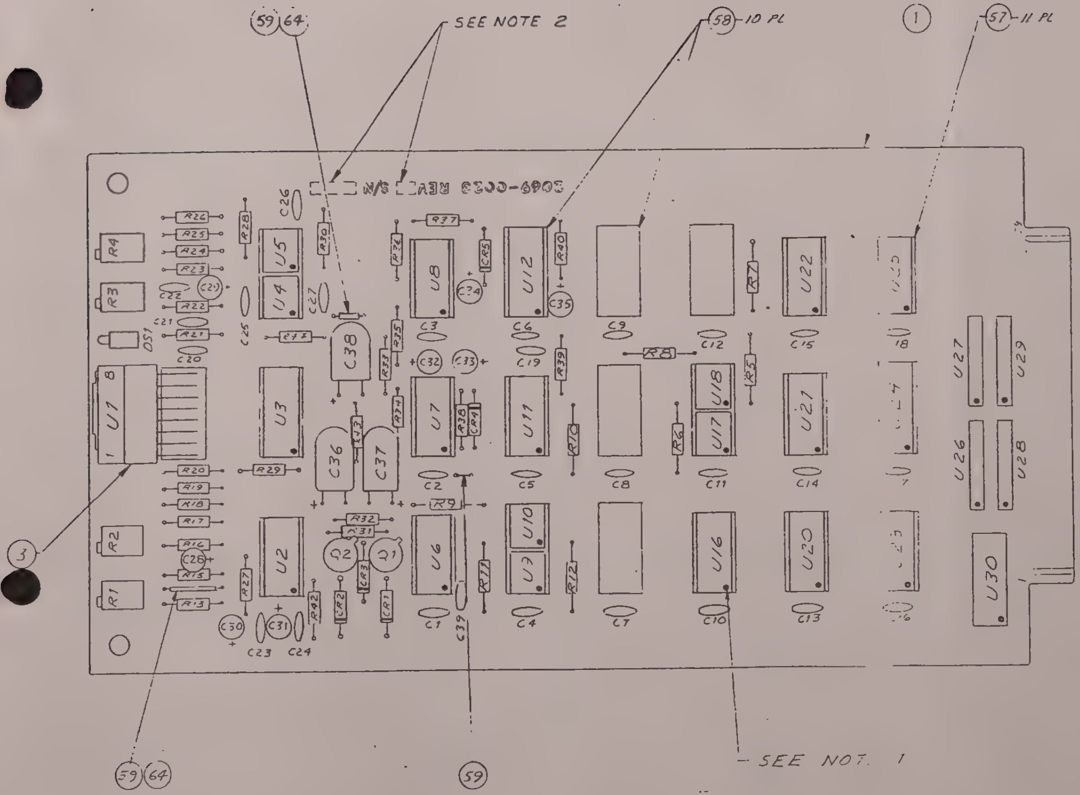
Epsco INCORPORATED

41 PROVIDENCE HIGHWAY
WESTWOOD, MASS 02090

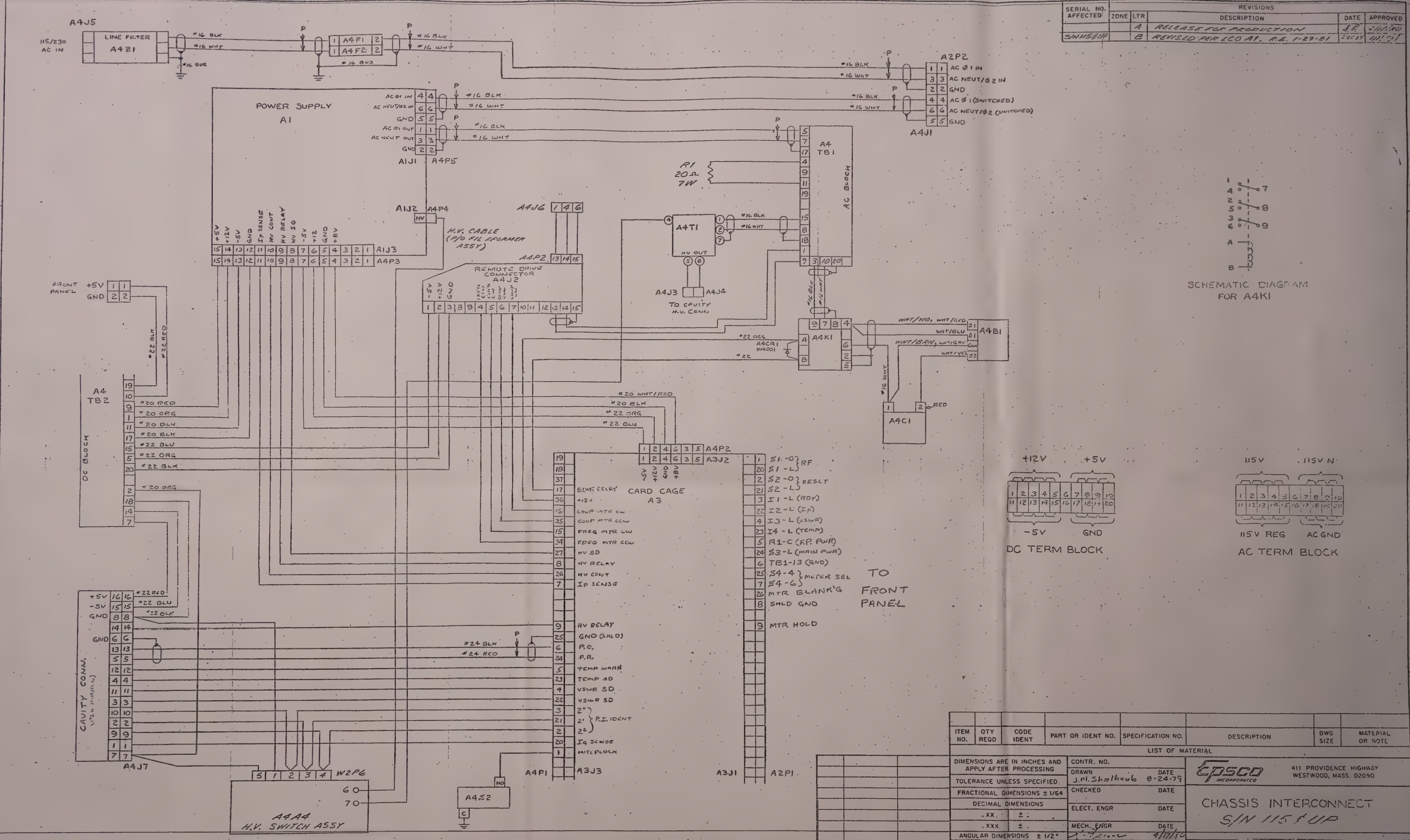
PRINTED WIRING ASSEMBLY
SYSTEM CONTROL BD.

SIZE D | CODE IDENT NO 99380 | 2069-0023 | REV A

SCALE 2/1 | WT CALC | ACT | SHEET 1 OF 2


59
64
SEE NOTE 2
58 10 PL
1
57 11 PL
S/N
REV
2069-0023
R26
R25
R24
R23
R22
R21
R4
R3
R2
R1
DS1
C20
C21
C22
C23
C24
C25
C26
C27
C28
C29
C30
C31
R28
R30
U5
U4
U3
U2
U1
R29
R20
R19
R18
R17
R16
R15
R13
R27
R42
R41
C38
C36
C37
R43
R32
R31
Q2
Q1
CR1
CR2
CR3
CR4
CR5
R33
R34
R35
R36
R37
R38
U8
U7
U6
C3
C32
C33
C2
R9
C1
C39
U12
U11
U10
U9
R40
C34
C35
C6
C19
C5
C4
R39
R10
R11
R12
C9
C8
C7
R8
C12
C11
C10
R6
R7
R5
U18
U17
U16
U22
U21
U20
C15
C14
C13
U27
U29
U26
U28
U30
3
59
64
59
SEE NOTE 1

SIZE	CODE IDENT NO		REV
D	99380	2069-0023	A
SCALE 2/1	WT CALC	ACT	SHEET 2 OF 2


A4J5
115/230 AC IN
LINE FILTER A4Z1
#16 BLK
#16 WHT
#16 BUS
P
A4F1
A4F2
POWER SUPPLY A1
AC Ø1 IN
AC NEUT/Ø2 IN
GND
AC Ø1 OUT
AC NEUT OUT
A1J1
A4P5
A1J2
A4P4
HV
H.V. CABLE (P/O FIL XFORMER ASSY)
+5V
+12V
-5V
GND
IP SENSE
HV CONT
HV RELAY
HV SD
-5V
+12
GND
+8V
A1J3
A4P3
A4J6
A4P2
REMOTE DRIVE CONNECTOR A4J2
A2P2
AC Ø1 IN
AC NEUT/Ø2 IN
GND
AC Ø1 (SWITCHED)
AC NEUT/Ø2 (SWITCHED)
GND
A4J1
A4 TB1
AC BLOCK
R1 20Ω 7W
A4T1
HV OUT
A4J3
A4J4
TO CAVITY H.V. CONN
#16 BLK
#16 WHT
A4K1
A4CR1 IN4001
#22 ORG
#22
WHT/VIO, WHT/RED
WHT/BLU
WHT/BRN, WHT/GRN
WHT/YEL
A4B1
Ø1
Ø1
COM
Ø2
A4C1
RED
FRONT PANEL +5V
GND
#22 BLK
#22 RED
A4 TB2
DC BLOCK
#20 RED
#20 ORG
#20 BLU
#20 BLK
#22 BLU
#22 ORG
#22 BLK
#20 ORG
#20 WHT/RED
#20 BLK
#22 ORG
#22 BLU
A4P2
A3J2
-5V
+12V
GND
+8V
CARD CAGE A3
BLWR RELAY
+12V
COUP MTR CW
COUP MTR CCW
FREQ MTR CW
FREQ MTR CCW
HV SD
HV RELAY
HV CONT
IP SENSE
HV RELAY
GND (SHLD)
P.C.
P.R.
TEMP WARN
TEMP SD
VSWR SD
VSWR SD
2^0
2^1
2^2
P.I. IDENT
IG SENSE
INTERLOCK
#24 BLK
#24 RED
A4P1
A3J3
A3J1
A2P1
S1-O
S1-L
RF
S2-O
S2-L
RESET
I1-L (RDY)
I2-L (IP)
I3-L (VSWR)
I4-L (TEMP)
R1-C (F.P. PWR)
S3-L (MAIN PWR)
TB1-13 (GND)
S4-4
S4-6
METER SEL
MTR BLANK'G
SHLD GND
MTR HOLD
TO FRONT PANEL
CAVITY CONN. (VIEW MATING)
+5V
-5V
GND
GND
#22 RED
#22 BLU
#22 BLK
A4J7
W2P6
A4A4 H.V. SWITCH ASSY
A4S2
NO
C
SCHEMATIC DIAGRAM FOR A4K1
+12V
+5V
-5V
GND
DC TERM BLOCK
115V
115V N
115V REG
AC GND
AC TERM BLOCK
2069-2408

SERIAL NO. AFFECTED	REVISIONS ZONE	LTR	DESCRIPTION	DATE	APPROVED
		A	RELEASE FOR PRODUCTION	S.F.	1/11/80
S/N 115 & UP		B	REVISED PER ECO A1. R.S. 1-29-81	2-25-81	

ITEM NO.	QTY REQD	CODE IDENT	PART OR IDENT NO.	SPECIFICATION NO.	DESCRIPTION	DWG SIZE	MATERIAL OR NOTE

LIST OF MATERIAL

DASH No	NEXT ASSY	USED ON
		EP 250C

APPLICATION

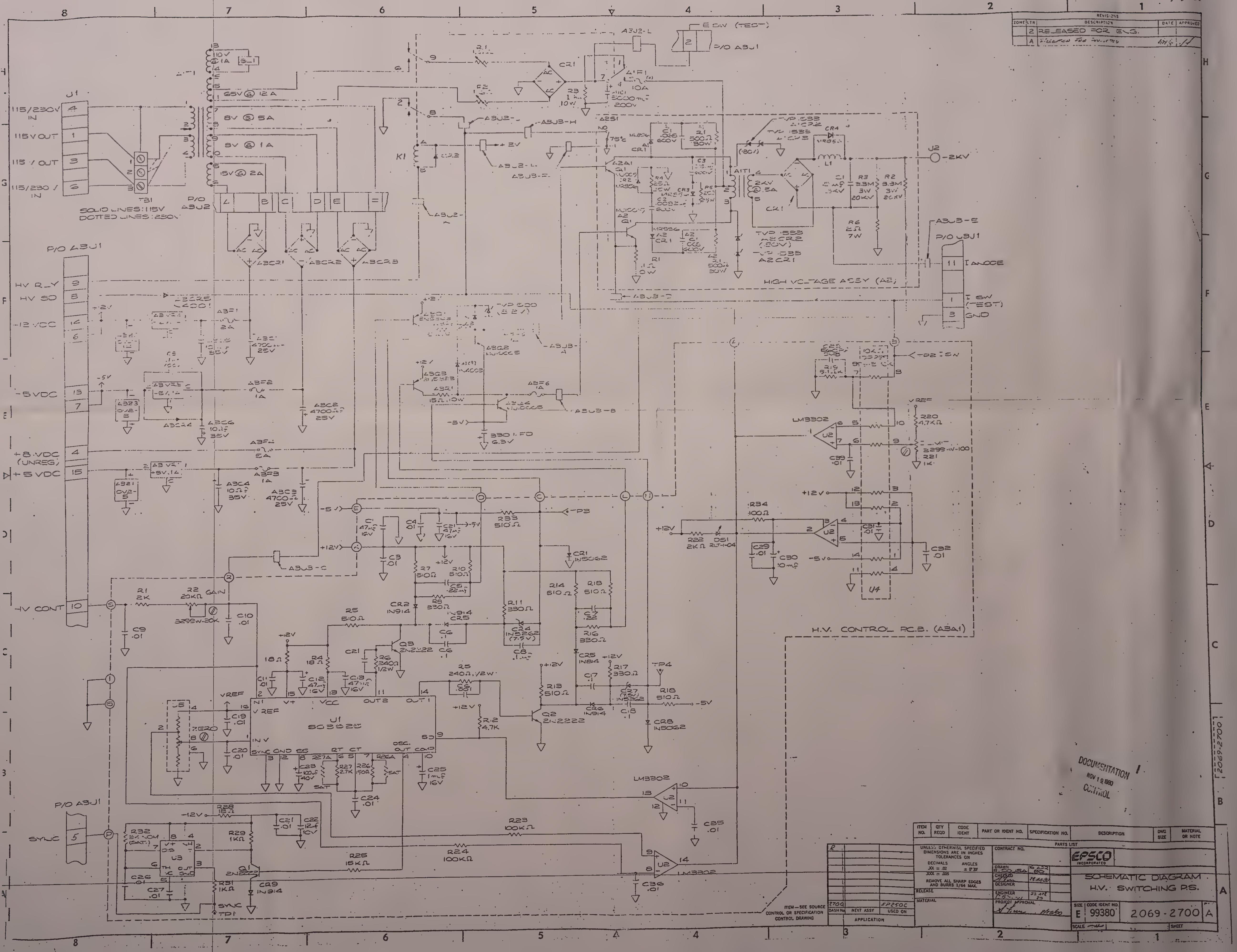
DIMENSIONS ARE IN INCHES AND APPLY AFTER PROCESSING
TOLERANCE UNLESS SPECIFIED
FRACTIONAL DIMENSIONS ± 1/64
DECIMAL DIMENSIONS
.XX ±
.XXX ±
ANGULAR DIMENSIONS ± 1/2°
REMOVE BURRS AND SHARP EDGES .015 R MAX.
MATERIAL

CONTR. NO.
DRAWN J.M. Shalhoub DATE 8-24-79
CHECKED DATE
ELECT. ENGR DATE
MECH. ENGR DATE 4/17/80
APPROVED DATE
APPROVED DATE

Epsco INCORPORATED
411 PROVIDENCE HIGHWAY
WESTWOOD, MASS. 02090

CHASSIS INTERCONNECT
S/N 115 & UP

SIZE D
CODE IDENT NO. 99380
2069-2408
REV. B
SCALE —
WT CALC ACT
SHEET 1 OF 1


J1
115/230V IN 4
115V OUT 1
115V OUT 3
115/230V IN 6
TB1
SOLID LINES: 115V
DOTTED LINES: 230V
P/O A3U2
10V @ 1A
65V @ 12A
8V @ 5A
8V @ 1A
15V @ 2A
A3CR1
A3CR2
A3CR3
K1
CR1
F1
F2
A3U2-L
E SW (TEST)
P/O A3J1
A3U3-H
A3U2-K
A3U3-F
A2S1
A2A1
A1T1
CR4
L1
J2
-2KV
R3 3.3M 3W 20KV
R2 3.3M 3W 20KV
R6 2Ω 7W
A3U3-E
P/O U3J1
I ANODE
I SW (TEST)
GND
HIGH VOLTAGE ASSY (A2)
P/O A3J1
HV RLY 9
HV SD 8
-12 VCC 14
6
-5VDC 13
7
+8 VDC (UNREG) 4
+5 VDC 15
A3F1 2A
A3F2 1A
A3F3 1A
A3F4 5A
A3C1 4700μF 25V
A3C2 4700μF 25V
A3C3 4700μF 25V
A3Q2
A3Q3
A3Q4
A3F6 1A
A3U3-B
A3U3-A
330 μFD 6.3V
-5V
+12V
A3U3-C
R33 510Ω
R34 100Ω
R22 2KΩ
DS1
C29 .01
C30 10μF
C31 .01
C32 .01
U4
LM3302
U2
R20 4.7KΩ
R21 1K
VREF
H.V. CONTROL P.C.B. (A3A1)
HV CONT 10
R1 2K
R2 20KΩ GAIN
C9 .01
C10 .01
U1 SG3525
VREF
N I
INV
SYNC
GND
SS
RT
CT
OSC OUT
COMP
OUT 2
OUT 1
VCC
Q3 2N2222
Q2 2N2222
R5 240Ω 1/2W
R12 4.7K
R13 510Ω
R17 330Ω
R18 510Ω
TP4
CR8 1N5062
CR1 1N5062
CR2 1N914
CR5 1N914
CR6 1N914
CR7 1N5062
P/O A3J1
SYNC 5
U3
R32
R29 1KΩ
R28 15Ω
-12V
C21 .01
C22
Q1 2N2222
R31 1KΩ
CR9 1N914
SYNC TP1
R23 100KΩ
R24 100KΩ
R25 15KΩ
LM3302
C35 .01
C36 .01
8 7 6 5 4 3 2 1
H G F E D C B A

ZONE	LTR	DESCRIPTION	DATE	APPROVED
	2	RELEASED FOR ENG.		
	A	Released for Inventory		

DOCUMENTATION
NOV 19 1980
CONTROL

ITEM NO.	QTY REQD	CODE IDENT	PART OR IDENT NO.	SPECIFICATION NO.	DESCRIPTION	DWG SIZE	MATERIAL OR NOTE

PARTS LIST

DASH No	NEXT ASSY	USED ON
2700		EP250C

APPLICATION

ITEM—SEE SOURCE CONTROL OR SPECIFICATION CONTROL DRAWING

UNLESS OTHERWISE SPECIFIED DIMENSIONS ARE IN INCHES
TOLERANCES ON
DECIMALS .XX = .02 .XXX = .005
ANGLES ± 0°30'
REMOVE ALL SHARP EDGES AND BURRS 1/64 MAX.

RELEASE

MATERIAL

CONTRACT NO.

DRAWN R. SOUSA 16 APR 80
CHECKED 28 Apr 80
DESIGNER
ENGINEER 22 APR 80
PROJECT APPROVAL

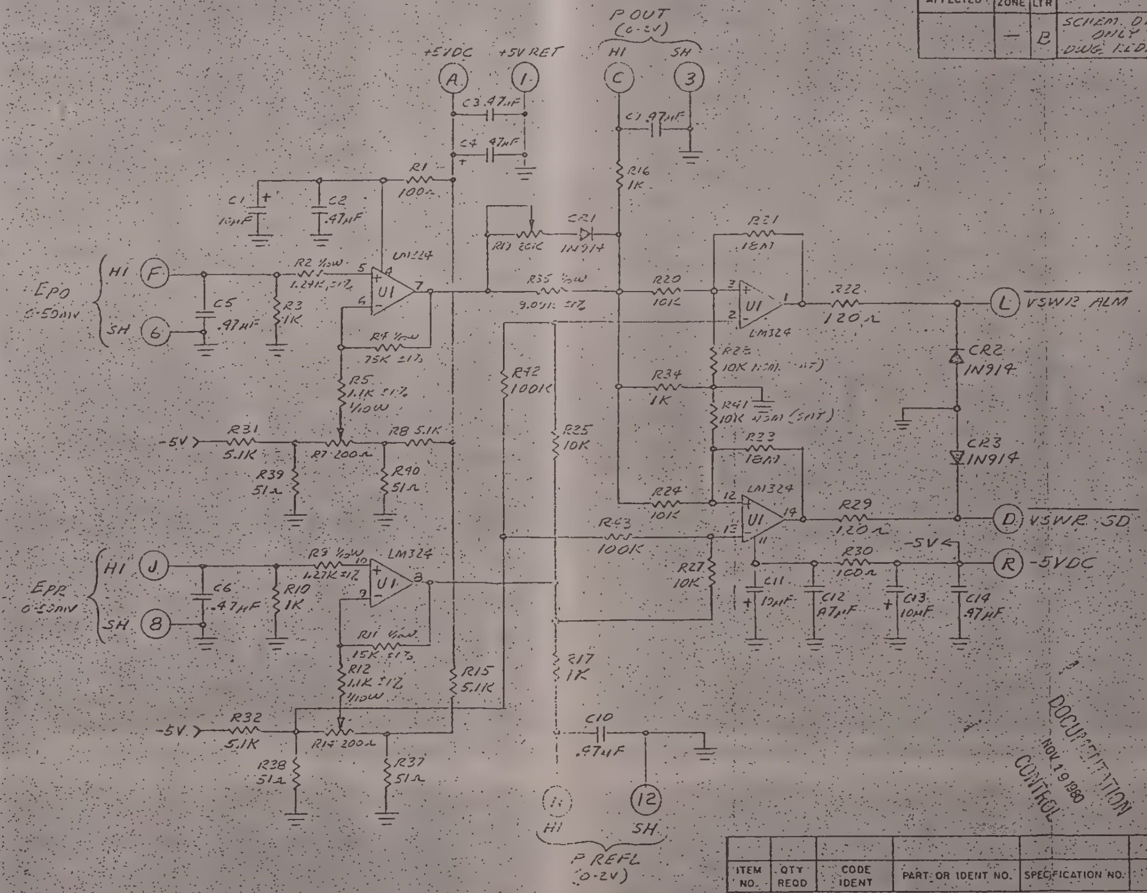
EPSCO INCORPORATED

SCHEMATIC DIAGRAM
H.V. SWITCHING P.S.

SIZE E
CODE IDENT NO. 99380
2069-2700
A

SCALE —
SHEET

SERIAL NO. AFFECTED	ZONE	LTR	DESCRIPTION	DATE	APPROVED
	—	B	SCHEM. DWG. FOR S/N-001 THRU 015 ONLY SEE ECO A1. DWG. REDRAWN & REVISED PER ECO A2		


4
3
2
1
D
C
B
A
+5VDC
+5V RET
P OUT
(0-2V)
HI
SH
A
1
C
3
C3 .47μF
C4 .47μF
C7 .47μF
R1
100Ω
C1
10μF
C2
.47μF
R16
1K
R17 20K
CR1
1N914
R21
18M
EPO
0-50mV
HI
SH
F
6
C5
.47μF
R2 1/10W
1.24K ±1%
R3
1K
LM324
U1
5
6
7
R4 1/10W
75K ±1%
R35 1/10W
9.09K ±1%
R20
10K
3
2
1
U1
LM324
R22
120Ω
L
VSWR ALM
CR2
1N914
R5
1.1K ±1%
1/10W
R42
100K
R26
10K (NOM SEL)
R34
1K
R41
10K NOM (SEL)
R25
10K
R23
18M
CR3
1N914
-5V
R31
5.1K
R7 200Ω
R8 5.1K
R39
51Ω
R40
51Ω
R24
10K
LM324
12
14
13
11
U1
R29
120Ω
D
VSWR SD
R43
100K
R27
10K
-5V
R30
100Ω
R
-5VDC
C11
10μF
C12
.47μF
C13
10μF
C14
.47μF
EPR
0-50mV
HI
SH
J
8
C6
.47μF
R9 1/10W
1.27K ±1%
R10
1K
LM324
U1
10
9
8
R11 1/10W
75K ±1%
R12
1.1K ±1%
1/10W
R15
5.1K
R17
1K
-5V
R32
5.1K
R14 200Ω
R38
51Ω
R37
51Ω
C10
.47μF
11
12
HI
SH
P REFL
(0-2V)

UNLESS OTHERWISE SPECIFIED
ALL RESISTORS ARE 1/4 WATT ±5%
ALL RESISTANCE VALUES ARE EXPRESSED IN OHMS
1 K = 1000. 1 MEG = 1,000,000
ALL CAPACITANCE VALUES ARE EXPRESSED IN MICROMICROFARADS
1μF = 1,000,000 MICROMICROFARADS
ALL INDUCTANCE VALUES ARE EXPRESSED IN MICROHENRYS
1 MH = 1000 MICROHENRYS
1H = 1,000,000 MICROHENRYS
ALL TRANSISTORS ARE
ALL DIODES ARE 1N914

DOCUMENTATION
NOV 19 1980
CONTROL

ITEM NO.	QTY REQD	CODE IDENT	PART OR IDENT NO.	SPECIFICATION NO.	DESCRIPTION	DWG SIZE	MATERIAL OR NOTE

LIST OF MATERIAL

2726	-0026	322 50C
DASH No.	ASSY	USED ON

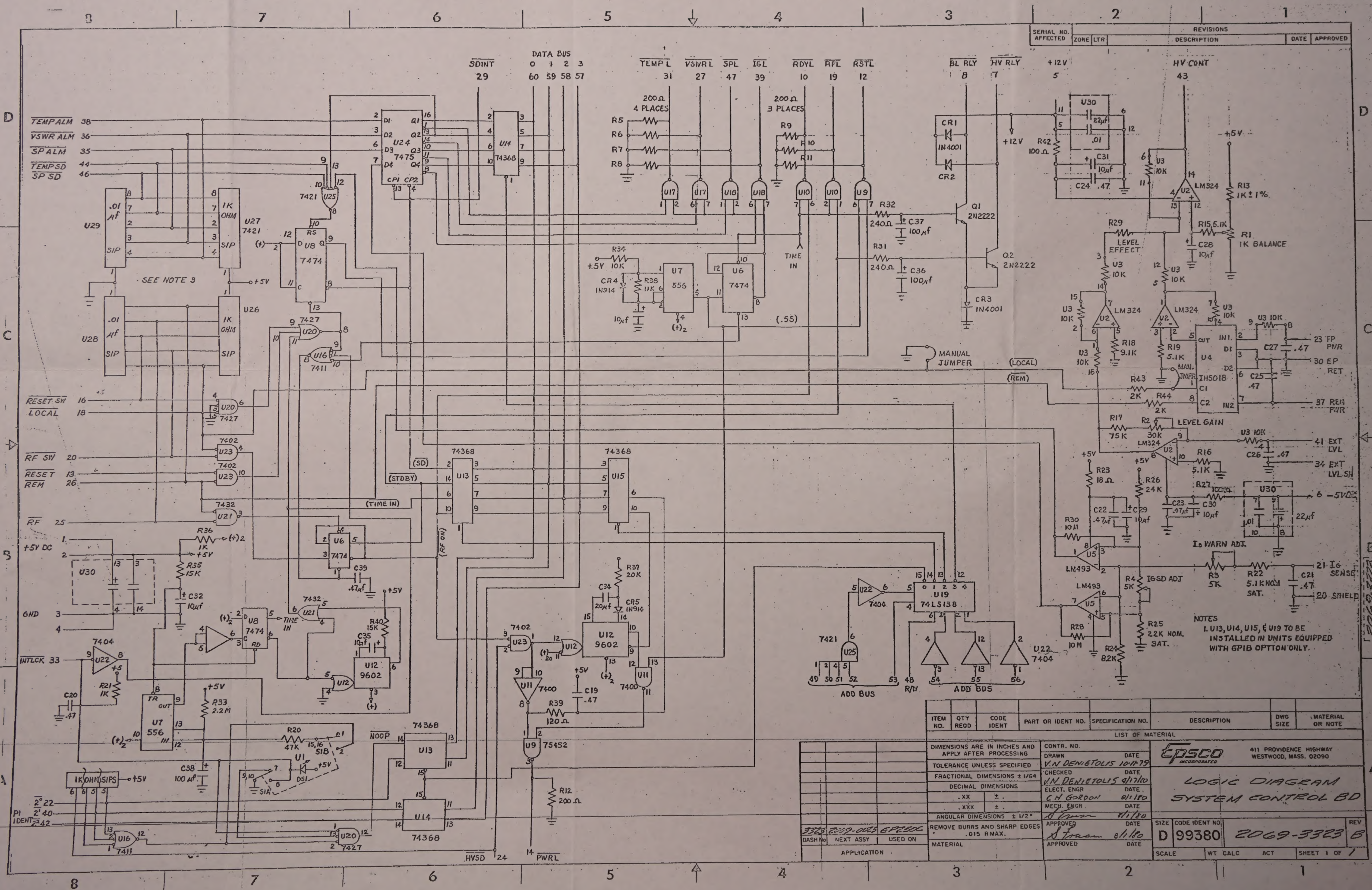
DIMENSIONS ARE IN INCHES AND APPLY AFTER PROCESSING
TOLERANCE UNLESS SPECIFIED
FRACTIONAL DIMENSIONS ± 1/64
DECIMAL DIMENSIONS
.XX ±
.XXX ±
ANGULAR DIMENSIONS ± 1/2°
REMOVE BURRS AND SHARP EDGES .015 RMAX.
MATERIAL

CONTR. NO.
DRAWN M. DEMETROLIS DATE 6/22/80
CHECKED DATE
ELECT. ENGR DATE
MECH. ENGR DATE
APPROVED DATE
APPROVED DATE

EPSCO INCORPORATED
411 PROVIDENCE HIGHWAY
WESTWOOD, MASS. 02090

SCHEMATIC DIAGRAM
PWR METER AMP &
HIGH VSWR DET

SIZE	CODE IDENT NO.		REV
C	99380	2069-2726	B



TEMP ALM 38
VSWR ALM 36
SP ALM 35
TEMP SD 44
SP SD 46
RESET SW 16
LOCAL 18
RF SW 20
RESET 13
REM 26
RF 25
+5V DC
GND
INTLCK 33
IDENT
SEE NOTE 3
SDINT 29
DATA BUS
0 1 2 3
60 59 58 57
TEMP L 31
VSWR L 27
SPL 47
IGL 39
RDYL 10
RFL 19
RSTL 12
BL RLY 8
HV RLY 7
+12V 5
HV CONT 43
200Ω 4 PLACES
200Ω 3 PLACES
U24 7475
U14 74368
U29 SIP
U28 SIP
U27 7421
U26
U25 7421
U8 7474
U7 556
U6 7474
U20 7427
U16 7411
U23 7402
U21 7432
U13 74368
U15 74368
U12 9602
U19 74LS138
U22 7404
U9 75452
U11 7400
U4 IH5018
U2 LM324
U3 LM324
U5 LM493
U30
Q1 2N2222
Q2 2N2222
CR1 IN4001
CR2
CR3 IN4001
CR4 IN914
CR5 IN914
TIME IN
(.5S)
MANUAL JUMPER
(LOCAL)
(REM)
(SD)
(STDBY)
(TIME IN)
(RF ON)
LEVEL EFFECT
LEVEL GAIN
R1 1K BALANCE
R13 1K ±1%
IG WARN ADJ.
IGSD ADJ
R3 5K
R22 5.1K NOM SAT.
R25 2.2K NOM. SAT.
23 FP PWR
30 EP RET
37 REM PWR
41 EXT LVL
34 EXT LVL SW
6 -5VDC
21 IG SENSE
20 SHIELD
ADD BUS
R/W
NOOP
HVSD 24
PWRL 14

NOTES
1. U13, U14, U15, & U19 TO BE INSTALLED IN UNITS EQUIPPED WITH GPIB OPTION ONLY.

SERIAL NO. AFFECTED	ZONE	LTR	DESCRIPTION	DATE	APPROVED

REVISIONS

ITEM NO.	QTY REQD	CODE IDENT	PART OR IDENT NO.	SPECIFICATION NO.	DESCRIPTION	DWG SIZE	MATERIAL OR NOTE

LIST OF MATERIAL

DASH No	NEXT ASSY	USED ON
3323	2069-0025	EP250C

APPLICATION

DIMENSIONS ARE IN INCHES AND APPLY AFTER PROCESSING
TOLERANCE UNLESS SPECIFIED
FRACTIONAL DIMENSIONS ± 1/64
DECIMAL DIMENSIONS
.XX ±.
.XXX ±.
ANGULAR DIMENSIONS ± 1/2°
REMOVE BURRS AND SHARP EDGES .015 RMAX.
MATERIAL

CONTR. NO.
DRAWN V.N DENIETOLIS DATE 10-11-79
CHECKED V.N DENIETOLIS DATE 4/17/80
ELECT. ENGR C H GORDON DATE 8/1/80
MECH. ENGR S Fraser DATE 8/1/80
APPROVED S Fraser DATE 8/1/80
APPROVED DATE

Epsco INCORPORATED
411 PROVIDENCE HIGHWAY
WESTWOOD, MASS. 02090

LOGIC DIAGRAM
SYSTEM CONTROL BD

SIZE D CODE IDENT NO 99380 2069-3323 REV B
SCALE WT CALC ACT SHEET 1 OF 1

2069-3323